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# NASA TECHNICAL MEMORANDUM

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TRANSFER ACTIVITY CONTRACTS REVIEW (NASA)  
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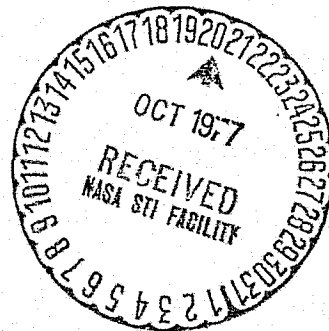
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## EARTH RESOURCES — REGIONAL TRANSFER ACTIVITY CONTRACTS REVIEW AND SUMMARY

By J. Bensko, Jr., J. L. Daniels, S. W. Downs, Jr.,  
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Data Systems Laboratory

August 1977

NASA



*George C. Marshall Space Flight Center  
Marshall Space Flight Center, Alabama*

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## 16. ABSTRACT

The Earth Resources Office, Data Systems Laboratory, Marshall Space Flight Center, hosted a Regional Transfer Activity Contracts Review on February 15-17, 1977. Twenty-one contracts in the Earth resources field primarily directed toward applications of satellite data and technology in solution of state and regional problems were reviewed.

This report gives a summary of the progress of each contract. The purpose of the review, and of this report, is to encourage the sharing of experiences of the researchers across a seven-state region. The region includes Missouri, Kentucky, Tennessee, Mississippi, Alabama, Georgia, and North Carolina.

In addition to research in several Earth science disciplines, which included forestry, limnology, water resources, land-use, geology, and mathematical modeling, the use of computers for establishment of information retrieval systems in the several states was emphasized.

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## EARTH RESOURCES – REGIONAL TRANSFER ACTIVITY CONTRACTS REVIEW AND SUMMARY

### I. INTRODUCTION

The Earth Resources Office hosted a Regional Transfer Activity Contract Review on February 15-17, 1977. In addition to being a legal contract review, an important additional purpose of the joint review was to enable contractors to see what others were doing within their mutual objective of transfer of advanced technology to solve regional problems. Such sharing of experiences would serve to avoid unnecessary duplications of successes and errors.

The program was conducted according to the poster session concept. In this format, contractors were provided with bulletin-board space on which to display various charts, graphs, diagrams, maps, imagery, or text to illustrate major points of their presentations. The poster sessions provided a convenient mechanism for informal discussions and comparisons of each contractor's results with similar materials of other attendees. In addition to the contractors' presentations, comments were offered by several visiting groups involved in regional transfer activities.

This report contains summaries of the contractors' presentations. These summaries were written by the authors of this report, not by the contractors. They are intended to give highlights of each activity as it existed in mid-February 1977. Some contracts were at an intermediate phase; therefore, more results would be expected later. Each contract had, or will have, formal reports of much greater detail. These should be consulted for further information. All final reports will eventually be available through the National Technical Information System (NTIS), U.S. Department of Commerce, Springfield, Virginia 22161.

A copy of the invitation letter, list of attendees, and schedule of presentations are given in Appendix A. The scope of work for each contract is given in Appendix B.

## II. SUMMARIES OF PRESENTATIONS

### REMOTE SENSING APPLICATION TO REGIONAL ACTIVITIES IN TENNESSEE — NAS8-31980

University of Tennessee Space Institute, Tullahoma, Tennessee —  
Nancy Jones and Leslie Sharber

The objective of this activity was to demonstrate the feasibility of remote sensing applications to potential users with specific problems which could possibly be alleviated by such technological applications. Two users who identified specific problems to the University of Tennessee Space Institute (UTSI) were the U.S. Soil Conservation Service (SCS) in Tennessee and the Tennessee State Planning Office (TSPO).

A study was made for SCS to demonstrate the application and utilization of Landsat imagery for determining land use of selected watershed areas in west Tennessee with special emphasis on determining wetland boundaries. UTSI made a study for TSPO to determine the accuracy of Landsat imagery for measuring strip mines of the size common in east Tennessee and to examine the possibility of detecting and mapping strip mine subcategories.

For both of these problems, sample areas were selected for detailed analysis. Landsat imagery and supplementary aircraft photography of the respective test areas were obtained and submitted to multilevel analysis using conventional photo interpretation methods, densitometric techniques, multispectral analysis, and statistical testing. As a result of these analyses, it was determined that Landsat data in imagery form could be used effectively to provide needed resource information for management and preservation programs by the respective agencies.

### THE VERIFICATION OF LANDSAT DATA IN THE GEOGRAPHICAL ANALYSIS OF WETLANDS IN WEST TENNESSEE — NAS8-31143

University of Tennessee, Knoxville, Tennessee —  
John Rehder and Dale Quattrochi

This project was designed to assess the reliability of Landsat imagery as a medium for identifying, delimiting, monitoring, measuring, and mapping wetlands in west Tennessee. The research objective was to verify Landsat as

an accurate, efficient cartographic tool that could be employed by a wide range of users to study wetland dynamics.

The verification procedure developed for the project was based on the visual interpretation and measurement of multispectral/multiscale imagery. The accuracy testing procedure was predicated on surrogate ground truth data gleaned from medium altitude imagery of the wetlands. Fourteen sites or case study areas were selected from individual  $9 \times 9$  in. photo frames on the aerial photography. These sites were then used as data control calibration parameters for assessing the cartography accuracy of the Landsat imagery.

An analysis of results obtained from the verification tests indicated that 1:250,000 scale Landsat data were the most reliable scale of imagery for visually mapping and measuring wetlands using the area grid technique. The mean areal percentage of accuracy was 93.54 percent (real) and 96.93 percent (absolute). As a test of accuracy, the Landsat 1:250,000 scale overall wetland measurements were compared with an area cell mensuration of the swamplands from 1:130,000 scale color infrared U-2 aircraft imagery. The comparative totals substantiated the results obtained from the Landsat verification procedure. It was concluded from this study that Landsat data are an accurate medium for mapping, monitoring, and measuring wetlands, and could therefore be employed by user-oriented agencies as a reliable and economically advantageous alternative to aerial photography for wetlands data collection and management.

#### DEVELOPMENT OF ALABAMA RESOURCES INFORMATION SYSTEM — ARIS<sup>1</sup> — NAS8-30654

Auburn University, Auburn, Alabama — R. I. Vachon

This activity, funded jointly by NASA and the Alabama Development Office (Contract ALA-AU-X996-1000-6), was completed September 15, 1976. It accomplished the objective of designing and implementing an operational automated information system for the State of Alabama. In addition, a number of subobjectives were accomplished.

1. B. E. Herring and R. I. Vachon: Final Report, Contract NAS8-30654, School of Engineering, Auburn University, Auburn, Alabama, September 15, 1976.

The system implemented was an adaptation of the Maryland Automated Geographic Information System (MAGI), using software purchased from the Environmental Systems Research Institute (ESRI) of Redlands, California. The system is presently on an IBM computer owned by the state at Auburn, Alabama. Plans call for moving it to a computer in Montgomery with access by interactive terminals at key locations throughout the state.

The contracted activity included training workshops for state and regional government personnel and publication of user manuals. Details are given in the Final Report.

## APPLICATION TRANSFER ACTIVITY IN MISSOURI<sup>2</sup> — NAS8-31767

University of Missouri, Rolla, Missouri — David Barr

The primary objective of this activity was to facilitate the transfer of remote sensing technology to Missouri users. This also required some research relevant to needs of the state. Emphasis was on the use of satellite imagery. Projects included: land-use mapping, inventory of mined land, technique development, publication of users' guides, and training workshops.

Land use maps were produced by three interpretation approaches and a booklet, Mapping Land Use from Satellite Images — User's Guide, was published in January 1977. Also, research was performed and a user's guide, Interpretation of Mined Land Characteristics from Landsat Imagery, was published. As part of this research, two low-cost interpretation systems were developed, neither using a computer. These had total costs of \$ 10,700 and \$ 1,000, respectively.

Training workshops were organized and presented as follows:

1. Nine presentations involving the use of satellite images for agricultural purposes were given at regional Missouri Soil and Crop Conferences.
2. Two 1-day remote sensing workshops were organized and presented.
3. Numerous presentations and informal workshop sessions were conducted throughout the state.

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2. David J. Barr: Annual Progress Report, Contract NAS8-31767. Dept. of Min., Petr., and Geol. Eng., University of Missouri-Rolla, Rolla, Missouri, January 5, 1977.



REMOTE SENSING APPLICATIONS TO MISSOURI ENVIRONMENTAL  
RESOURCES INFORMATION SYSTEM<sup>3</sup> — NAS8-31766

University of Missouri, Rolla, Missouri — Robert E. Myers

This research had two objectives: (1) to provide an efficient system for retrieval of remotely sensed data to be used by natural resources oriented agencies, and (2) to design a natural resources data system that could meet the needs of state agencies.

Two projects were undertaken: (1) an inventory of remote sensing imagery in the Division of Geology and Land Survey, and (2) drafting of a conceptual design of a natural resources data sharing system. The former was accomplished and will be expanded to include an inventory of remotely-sensed data held in other state agencies. The latter design was drafted and turned over to the Interdepartmental Council for Natural Resources Information for implementation decisions. Both projects are described in detail in the Annual Report of January 15, 1977.

STATE AGENCY REMOTE SENSING DATA MANAGEMENT —  
NAS8-32354

Washington University, St. Louis, Missouri — Lester Eastwood

The objectives of this contract were to:

1. Identify a few high priority remote sensing products needed in Missouri that had been proven feasible.
2. Select and/or design an information extraction system to produce the products.
3. Select and/or design a data base management system for one or more Missouri agencies to combine the information contained in these products with other agency data.

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3. Robert E. Myers: Annual Report, Contract NAS8-31766. Missouri Department of Natural Resources, Rolla, Missouri, January 15, 1977.

4. Describe how the above items could be implemented within the political, institutional, and financial constraints of government.

The State of Missouri officially supported and participated in the project. The Missouri Interdepartmental Council on Natural Resources Information was the state formal contact. The Council, together with the contract principal investigators (PI's), selected two specific agencies as user-partners for the activity: The Office of Administration and Department of Natural Resources.

With the Office of Administration, the PI's explored the use of Landsat data for extending and enhancing the Land-Use and Data Analysis (LUDA) program which was being conducted in Missouri under a cooperative agreement with the USGS. With the Department of Natural Resources, the objective was to establish the best means of utilizing satellite data to assist in meeting the requirement for state-wide updating of freshwater impoundment inventory.

A number of existing NASA data base systems and data analysis techniques were investigated. The most promising system for the water impoundment inventory application was reported to be the Johnson Spacecraft Center (JSC) DAM package which was furnished by JSC for more detailed investigation.

#### REMOTE SENSING OF GEOBOTANICAL RELATIONS IN GEORGIA — NAS8-30884

Georgia Southwestern College, Americus, Georgia — Daniel D. Arden

The relationships of certain plants to rock and mineral occurrence demonstrably exist and are largely, though not exclusively, due to chemical factors. This investigation was concerned with how the geobotanical correlations could be identified by remote sensing techniques, and as a further qualification, how the techniques might be applied in the southeastern U.S.

Four specific categories of application were investigated in detail, and three others were pursued to the point of recommending the feasibility of further work. Success was mixed, and the results did not always confirm the anticipated outcome. New approaches developed during the progress of some projects, and efforts to solve a problem led to techniques not envisioned in the original plans. This was especially evident in the Dougherty County sinkhole investigations where remote sensing recognition of plant stress symptoms, combined with microgravity surveys, showed promise of a rapid and inexpensive means of evaluating the collapse potential of land under development.

## GROUND TRUTH VERIFICATION OF LAND-USE MAPS DERIVED FROM SATELLITE DATA<sup>4</sup> — NGR 01-001-023

Alabama A&M University, Normal, Alabama — Oscar Montgomery

Data from Landsat-1 were processed by a computer utilizing a linear classification algorithm to produce a land-use map of a five county area in north Alabama for the Top of Alabama Regional Council of Governments (TARCOG). Land-uses were assigned according to Level I of the USGS land cover classification system. A study was conducted to determine the accuracy of the map. There was good overall agreement between the land-use assigned by the computer and the actual condition as determined by ground checking, but there were also obvious discrepancies.

Two types of errors were encountered — shift and misclassification — and a method was developed to eliminate or greatly reduce the errors. Randomly selected study areas containing 2525 pixels were analyzed. Overall, 76.3 percent of the pixels were correctly classified. Forest land, water, and agricultural land had the highest correct classification. The study showed that land-use maps generated by computers from Landsat data are useful for overall land-use by regional agencies. However, care must be used when making detailed analysis of small areas.

## REMOTE SENSING OF STRIPPABLE COAL MINES — NAS8-31573

State of Alabama, Geological Survey of Alabama — P. A. Boone

The objective of the project was to depict estimated original in-ground and remaining strippable coal resources, thickness of coal and overburden, and general chemical character of the coal. Tabular data were generated to provide details on strippable coal reserves.

Two additional surface-mine mapping projects were reported to be underway. The first is a computer analysis of surface mines and coal resources which involves digitizing of drill-hole data and referencing by UTM grid, use of Army

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4. Sanford W. Downs, G. C. Sharma, and Colin Bagwell: A Procedure Used for A Ground Truth Study of A Land-Use Map of North Alabama Generated from Landsat Data. NASA TN D-8420, February 1977.

TOPCOM topographic digital tapes, and supplemental use of Landsat CCT's. The Georgia Institute of Technology is assisting the State Survey in the computer analysis.

The second on-going study involves a cooperative effort with the Mississippi State University Forestry Department to map existing patterns and attributes of surface mines in the entire Warrior Coal Field using Landsat CCT's. The automated analysis will be evaluated in terms of field data provided by the Geological Survey of Alabama, and the programs produced will be applicable to future up-dates of surface-mine patterns in Alabama.

#### REMOTE SENSING OF EFFECTS OF LAND-USE PRACTICES ON WATER QUALITY — NAS8-31006

University of Kentucky, Lexington, Kentucky — Donald Graves

Dr. Graves reported on an intensive 2-year study which was conducted to determine the utility of manual densitometry and color additive viewing of aircraft and Landsat transparencies for monitoring land-use and land-use change. The relationship between land-use and selected water quality parameters were also evaluated.

The results were that some correlation between densitometric data and some water quality parameters appeared to exist, but ground conditions were not diverse enough to allow meaningful extension of apparent correlations into areas other than the study area.

Color enhancement of medium scale multispectral transparencies with a manual color additive viewer offered some promise, particularly if multitemporal imagery of varying photo scale could be accommodated by the viewer used. For single date vegetation surveys, color infrared imagery offered equal or greater utility.

#### APPLICATION OF SATELLITE REMOTE SENSING TO NORTH CAROLINA — NAS8-31984

North Carolina State University, Raleigh, North Carolina —  
Charles W. Welby

The objective of this research was to work with state agencies in the selection of specific problems which could possibly be solved by satellite remote

sensing. After consultation with the North Carolina Office of Environmental Management and the North Carolina Fisheries and Wildlife Commission, the problem of determination of the trophic states of lakes was chosen. Four lakes were selected as test sites, all on the same Landsat scene.

From this study, it appeared possible to differentiate the coastal plain lakes into four broad groups. It was also possible to relate water quality parameters to reflectance characteristics within Lake Mattamuskeet. Nutrient measurements showed that Lake Mattamuskeet was more productive than Lake Phelps. Each of the two lakes had its own distinctive "mass character" which was sensed by Landsat. Thus, it appeared that not all of the variables could be directly correlated to the imagery and that the "mass character" might be more important than any specific parameter in detecting water quality by satellite. Reflectances recorded a balance among a large number of dependent variables.

#### COMPUTER PROCESSING OF PEACH TREE DECLINE DATA — NAS8-31850

Georgia Institute of Technology, Atlanta, Georgia — Nick L. Faust

The length of the bearing life of peach trees in the southeast has declined in recent years. This reduction in the life of the trees is a serious problem to the peach growers. A study was initiated in cooperation with the USDA-ARS station in Byron, Georgia to determine if computer processing of remotely-sensed data could be used as a means of early detection of peach tree decline.

Multispectral data in the visible, near infrared, and thermal bands were obtained by aircraft multispectral scanners. It was determined that the use of the thermal data alone would not necessarily allow early detection of the symptoms. However, when used in conjunction with the visible and near infrared data, indications were that early detection of peach tree decline would be possible.

#### LANDSAT INFORMATION FOR STATE PLANNING — NAS8-30653

Georgia Institute of Technology, Atlanta, Georgia — Nick L. Faust  
Metrics Inc., Atlanta, Georgia — G. W. Spann

One objective of this research was to transfer the software and technology for rapid computer processing and rectification of Landsat digital data to State of Georgia computers from various NASA centers. Another objective was to

become familiar with available information retrieval and data management systems throughout the country and to begin the transfer of an appropriate system or combination of systems to the State of Georgia. These systems were to be compatible with land cover information obtained via classification of Landsat data. A third objective was to communicate with various state and local agencies outside of Georgia about the possible uses of Landsat data in their operations.

During the past year, the Earth Resources Data Analysis System (ERDAS) became operational. This system, bought with state funds for less than \$ 80,000, permits low-cost analysis of Landsat computer compatible tapes as a service to local agencies. ERDAS is based on a NOVA II minicomputer and a COMTAL 8100 color display.

Several technology transfer workshops were conducted, including one at Knoxville, Tennessee on July 16, 1976 and another at Atlanta, Georgia on January 28, 1977.

#### DATA COLLECTION SYSTEM OPERATION<sup>5</sup> — NAS8-31553

Marine Environmental Sciences Consortium, Dauphin Island Sea Lab,  
Dauphin Island, Alabama — William W. Schroeder

An evaluation was given of instrumented buoys functioning with Landsat data collection platforms in Mobile Bay. Surface hydrographic data taken over a 7-month period were utilized as sea truth data to support Landsat imagery and as time series data for environmental characterization studies. The results suggested that the sea truth application which requires data only once every 18 days cannot necessarily justify the use of data collection platforms. On the other hand, the time series application showed great promise because the entire data base generated by the buoys was used. A "Physical Environment Atlas of Coastal Alabama" document resulted from this work.

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5. William W. Schroeder: Physical Environment Atlas of Coastal Alabama. Marine Sciences Programs, University of Alabama, Dauphin Island, Alabama.

## REMOTE SENSING AND GROUND TRUTH DATA — NAS8-30810

Marine Environmental Sciences Consortium, Dauphin Island Sea Lab,  
Dauphin Island, Alabama — George Crozier

A summary was given of the results to date of using Landsat imagery and a towed transmissiometer to develop methods of determining sediment transport and flushing characteristics of Mobile Bay. One of the most difficult tasks of this study was trying to correlate percent light transmission readings with gravimetric analysis of grab samples. One interesting result was that wind resuspension of sediment was a major contributor to the bay turbidity.

## A THREE-DIMENSIONAL, TIME-DEPENDENT MODEL OF MOBILE BAY — NAS8-30380

Louisiana State University, Baton Rouge, Louisiana — F. H. Pitts

A three-dimensional, time-variant mathematical model for momentum and mass transport in estuaries was developed and its solution implemented on a digital computer. The mathematical model was based on state and conservation equations applied to turbulent flow of a two-component, incompressible fluid having a free surface. Thus, buoyancy effects caused by density differences between the fresh and salt water, inertia from the river and tidal currents, and differences in hydrostatic head were taken into account. The conservation equations, which are partial differential equations, were solved numerically by an explicit, one-step finite difference scheme and the solutions displayed numerically and graphically. To test the validity of the model, a specific estuary for which scaled model and experimental field data are available, Mobile Bay, was simulated. Comparisons of velocity, salinity, and water level data showed that the model is valid and a viable means of simulating the hydrodynamics and mass transport in nonidealized estuaries.

## WATER RESOURCES PLANNING FOR RIVERS DRAINING INTO MOBILE BAY — NAS8-29100

University of Alabama, University, Alabama — Gary April

As part of this study, MSFC funded projects to investigate the adaptation and implementation of existing mathematical modeling methods for the purpose

of describing the behavior of Mobile Bay. Of particular importance were the interactions that system variables such as river flow rate, wind direction and speed, and tidal state have on the water movement and quality within the bay system.

Specific achievements of these modeling studies included:

1. The development of a rapid, predictive technique for establishing baseline conditions.
2. The determination of the dynamic interchange occurring between the bay and rivers.
3. The investigation of bay physiochemical processes and the impact that these have on the water mass.
4. The determination of material transport behavior within the water system as controlled by system variables (salinity, sediment transport, coliform bacteria).
5. The establishment of a basic model.
6. The development of a method to interface the bay model with selected subsystems designed to provide a closeup view of certain local disturbances (dredge discharge material transport, Little Dauphin Bay Model).
7. The establishment of a method with the capability of interacting with field oriented, data processing, and remote sensing programs which are concurrent with this contract.

USE OF REMOTE SENSING TECHNIQUES FOR GEOLOGICAL  
HAZARD SURVEYS IN VEGETATED URBAN  
REGIONS - NAS8-31979

University of Alabama, University, Alabama — Travis Hughes

The primary objective of this study was to examine the feasibility of using aerial photography for lithologic differentiation in a heavily vegetated region. Analyses of multispectral photographs taken in vegetative regions



indicated that rock types could be differentiated. Studies were conducted to show the correlation between tonal values of the multispectral images and ground truth data such as lithology and moisture percent. High correlation was noted for both the red and infrared bands. Lithologic map construction when using the red and infrared bands increased significantly when maps were drawn in conjunction with existing ground truth data. Characteristic signatures were developed to delineate broad lithologic types. It was concluded that multispectral analysis for lithologic determinations would prove beneficial if limited time were a factor and if areas to be mapped had limited accessibility.

Another phase of this contract dealt with a study to determine if Landsat and U-2 imagery could be useful for mapping flooded and flood-prone areas or could serve as a means for the verification of existing flood hazard maps. It was concluded that not only was Landsat and U-2 imagery useful for such applications, but also the costs for Landsat and U-2 flood hazard mapping were considerably less than the traditional methods of flood-prone mapping and did not require the prior existence of topographical or soils maps. Therefore, their use for flood hazard mapping could be readily applied to underdeveloped areas in large scale land-use evaluations.

#### USER ASSISTANCE APPLICATION IN EAST MISSISSIPPI — NAS8-31785

Mississippi State University, Mississippi State, Mississippi — Frank Miller

The primary objective of this contract effort was to assist the East Mississippi Council and other organizations within the Tennessee-Tombigbee Waterway area in meeting their current and future planning and development requirements and responsibilities in a more efficient way by (1) acquainting them with information extraction and interpretation techniques using remote sensing data and technology, and (2) demonstrating application of this information in various fields involving economic and development planning with specific concentration on the impact of the Tennessee-Tombigbee Canal project activity.

Mississippi State University organized and conducted two workshops emphasizing these objectives. In addition to the workshops, the University was requested to outline a plan for storage, retrieval, and transfer system that would be applicable to needs of Mississippi users. The system was to be based on existing technological systems using remote sensing as a major input.

MSFC funded an extension of the contract to assist Mississippi State University in initiating and extending the application of the information system planned and explored in conjunction with the workshops. The primary accomplishments of this phase were (1) the selection of a user-partner for a demonstration, Loundee County, Mississippi, and (2) the purchase of a magnetic tape recorder to complete the Mississippi State computer graphics and image processing capability which would support realtime applications for the waterway area agencies.

RESEARCH STUDY ON THE APPLICATION OF REMOTE SENSING  
TO THE DEVELOPMENT AND FORMULATION OF HYDROLOGIC  
PLANNING MODELS — NAS8-30539

Ecosystems International, Inc., Gambrells, Maryland —  
Peter Castruccio

This was an investigation of the application of remote sensing to the development and formulation of hydrologic planning models using Landsat imagery.

The structure of the prediction model was described, and the results indicated that within the range of applicability of its simplified version the new model appeared to be considerably more accurate than conventional hydrologic planning models. Specifically in six out of nine of the watersheds tested, the new model supplied predictions of peak flow for the 50 year event falling within error bounds of  $\pm 15$  percent. For these same six watersheds, conventional models yielded discrepancies with respect to the records ranging from a minimum of 1.2 to 1 to a maximum of 15 to 1. For the three remaining watersheds, the new model yielded predictions of lesser accuracy, the worst being 2 to 1.

Reasonable explanations for the discrepancy are (1) that the model was oversimplified by not operating it in its fully interconnected version, and (2) the three watersheds are considerably more complex than the other six, and they need to be split into subwatersheds, predicting the output from these, then routing all outputs through the watershed channels. This technique is proposed for future phases of the effort.

PLANNING FOR A CENTER FOR INFORMATION, EDUCATION,  
AND TECHNOLOGY DEVELOPMENT IN REMOTE SENSING —  
NAS8-32218

University of Mississippi, University, Mississippi — Donald E. Walsh

This contract began December 1, 1976, and therefore had little progress to report. Exploratory discussions were held with representatives of Mississippi Power and Light, the Mississippi Oil and Gas Board, the Mississippi Research and Development Center, and the Arkansas Chapter, American Institute of Planners. Several items of laboratory equipment were purchased with University funds and installed.

APPENDIX A

INVITATION LETTER, LIST OF ATTENDEES,  
AND SCHEDULE OF PRESENTATIONS

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National Aeronautics and  
Space Administration

George C. Marshall Space Flight Center  
Marshall Space Flight Center, Alabama  
35812



Reply to Attn of

January 18, 1977

Dear Sir:

As you know, within our mutual objective of transfer of advanced technology to solve regional problems, we also have an obligation to share experiences with each other to avoid unnecessary duplications of successes and errors. For that reason, I think we should have a joint review of our progress on contracts, so that each of you may see what the others are doing. Any proprietary information should be omitted, but of course there is very little of that in our program. We may also be able to see examples of progress in other parts of the nation through cooperation with other NASA centers.

The contract review will require three days. The dates are February 15, 16, and 17.

For format, we will follow the lead of the next Ann Arbor symposium and use the 60 to 90-minute Poster Sessions concept. This will encourage communications between investigators and will remove the possibility of stiff formality. Projection equipment will be available for supplementary material; in fact, we will need each investigator to bring and leave 2 or 3 summary charts in vugraph format to aid us in the next NASA-wide review. Enclosed is a summary sheet on Poster Sessions.

Please advise me by January 24, 1977, if you will be able to participate. You will receive a program schedule and information on motel accommodations around February 1, 1977.

Sincerely,

*C. T. Paludan*

C. T. Paludan  
Chief  
Earth Resources Office  
Data Systems Laboratory

2 Enclosures:  
"Poster Sessions"  
List of Attendees

## POSTER SESSIONS

Poster Sessions, originally introduced in Europe, have recently been utilized effectively at scientific meetings in the U. S. , with generally favorable reaction from authors and attendees alike (see Science, 28 June, 1974, P. 1361).

In this format, authors are provided with bulletin-board space on which to display various charts, graphs, diagrams, maps, imagery and text, to illustrate major points of their presentation, and allowed adequate time (60 - 90 minutes) to informally discuss details with interested attendees. These presentations will be sequential, according to a schedule. Additionally, such sessions are expected to provide a convenient mechanism for discussion and comparison of the author's results with similar materials of other attendees.

Projection equipment (2 x 2 and 3 x 4-inch slides, and vugraphs) and light tables will be available for use in supplementing all poster presentations, and, in particular, for detailed discussion as required.

(Plagiarized from "Call for Papers, Eleventh International Symposium on Remote Sensing of Environment," ERIM, Ann Arbor, Michigan, 1976; by Ted Paludan, MSFC.)

List of Attendees at Earth Resources — Regional Transfer  
Activity Contract Review

Mahlon C. Hammetter  
Donald H. Graves  
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Tullahoma, Tennessee 37388

John B. Rehder  
Dale Quattrochi  
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University of Tennessee  
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Floyd Fessler  
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Soil Conservation Service  
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MARSHALL SPACE FLIGHT CENTER  
EARTH RESOURCES -- REGIONAL TRANSFER ACTIVITY  
CONTRACTS REVIEW, FEBRUARY 15 - 17, 1977  
DATA SYSTEMS LABORATORY, SCIENCE AND ENGINEERING  
BLDG. 4708, RM 250

Tuesday, February 15

8:00 AM Set Up Posters For Entire Meeting  
9:00 AM Welcome and Introductory Remarks by MSFC Personnel  
9:30 AM University of Tennessee Space Institute  
10:30 AM University of Tennessee - Knoxville  
11:00 AM Comments on Data Management by MSFC  
11:15 AM Comments by Tennessee State Planning Office  
11:30 AM Lunch Break; Cafeteria in Bldg. 4708  
12:15 PM Auburn University  
1:15 PM Comments by Alabama Development Office  
1:30 PM University of Missouri -- Columbia & Rolla  
2:30 PM Missouri Department of Natural Resources  
3:15 PM Washington University -- St. Louis  
4:15 PM Adjourn For Day

6:00 PM Optional informal social meeting at 707 Greene Street, S.E.

Wednesday, February 16

8:00 AM Set Up Any New Posters  
8:15 AM Georgia Southwestern College  
9:15 AM Alabama A&M University  
10:15 AM Geological Survey of Alabama  
11:15 AM Ecosystems International, Inc.  
12:00 AM Lunch Break  
1:00 PM North Carolina State University  
2:00 PM Georgia Institute of Technology  
3:00 PM Metrics, Inc.  
3:30 PM Comments by State of Georgia Visitors  
4:15 PM Adjourn For Day

(No social activities planned for Wednesday)

Thursday, February 17

8:00 AM Set Up Any New Posters  
8:15 AM Marine Environmental Sciences Consortium  
9:15 AM Louisiana State University  
10:15 AM University of Alabama (Hydrology)  
11:15 AM Mississippi State University  
12:15 PM Lunch Break  
1:00 PM University of Alabama (Geology)  
2:00 PM University of Kentucky  
3:00 PM Comments from University of Mississippi  
3:15 PM Comments from Other Visitors  
4:15 PM Adjourn

APPENDIX B  
CONTRACT SCOPES OF WORK

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## SCOPE OF WORK FOR CONTRACT NAS8-31980

University of Tennessee Space Institute

### BACKGROUND

Beginning in June 1971, the University of Tennessee Space Institute (UTSI) conducted several Earth resources research tasks under sponsorship of NASA. These included a study of potential uses of satellite and aircraft remote sensing for the southeastern U.S. (1971), and study of new remote sensing techniques (1972-1973). The latter was under a University Affairs grant, NGR 43-001-115. Beginning in March 1972, UTSI has sponsored an annual remote sensing symposium which has acquired international acclaim for excellence. UTSI now operates their own remote sensing airplane.

In summary, UTSI has established a unique capability for remote sensing of Earth resources in the southeastern U.S.

### WORK STATEMENT

The objective of the contract will be to establish joint activity with NASA and one or more selected state government agencies, so that a transfer of aerospace technology to state use will be encouraged. This will be accomplished by consultation with state agency personnel to define problems, by design of remote sensing experiments to attempt solutions, and by demonstration of the feasibility of technological applications to the potential user(s). The research and development required by the above objective will include the following elements:

1. Selection of State Agency Partners — The contractor will contact one or more state agencies with the objective of identification of important problems which would probably be alleviated by application of new technology. The agency(ies) selected must be cooperative to the extent that they would probably adopt proposed and feasible methods later with their own funds and resources, and they should be willing to provide written evaluations of results. The final choice of state agency partners must have approval of the NASA Contracting Officer's Representative or Alternate.

2. Definition of Problems — Problems selected for investigation will be limited to those believed by the contractor to be amenable to remote sensing solution. Remote sensing may be from aircraft or satellites, but preference will be given to research that ultimately depends upon satellite data only. More specifically, data from Skylab, Landsat-1, and Landsat-2 should be used, and projected use of Landsat-C's 40 m resolution system may be anticipated. It is critical that the problems be defined primarily by the state agency partner — less so by the contractor or NASA.

3. Definition of Remote Sensing Experiments — After problems are selected and defined, the contractor will design experiments for their solution. In general, experiments will probably include:

a. Data Acquisition — Satellite data may be purchased by the contractor with contract funds. The source of the data will be the U.S. Department of the Interior, EROS Data Center, Sioux Falls, South Dakota 57198. Aircraft data originating with NASA may be acquired from the same source. The contractor may use their own aircraft for medium altitude data-confirmation flights. The contractor may gather ground-truth data for confirmation and calibration of remotely-sensed data.

b. Data Interpretation — The contractor may apply densitometric and other analysis techniques, bearing in mind that the eventual state user may have to apply the same or similar technique.

c. Information Products — Analyzed data, termed "information," may be put into a form that constitutes a usable product. The format will be selected with the advice of the state agency. This might result, for example, in development of inexpensive black and white maps rather than color maps.

4. Demonstration — During the course of the research and development, informal liaison with the selected state agencies will serve to show how the technology can be applied to agency problems. This could lead to modifications in the development, based on feedback from the agency. Near the conclusion of the term of this contract, approximately November 1976, a formal demonstration presentation or workshop should be conducted by the contractor with the cooperation of the selected agencies and NASA. The purpose of this will be to show how the new technology can be transferred to operational use by the state agencies. Subsequently, a critique of each state agency's reaction to this should be obtained for inclusion in the final report.

## SCOPE OF WORK FOR CONTRACT NAS8-31143

University of Tennessee

### WORK STATEMENT

The contractor shall provide the necessary personnel and facilities to perform work, in conjunction with the Tennessee State Planning Office and MSFC, to verify that ERTS data may be used to update and map the wetlands of western Tennessee.

### COMPUTER REQUIREMENTS

The contractor shall provide its own computer in developing, debugging, and checking out the computer program. The program shall be written in Fortran language and be compatible with MSFC's computers. Sample case runs of the program can be accomplished here at MSFC utilizing MSFC computers.

### REPORTS REQUIREMENTS

1. Quarterly Progress Reports — The contractor shall submit separate quarterly progress reports of all work accomplished during each 3 months of contract performance. The reports shall be submitted by the 15th of the month following the quarter being reported. Reports shall be in narrative form and brief and informal in content. The reports shall include:

- a. A quantitative description of overall progress.
- b. An indication of any current problems which may impede performance and proposed corrective action.
- c. A discussion of the work to be performed during the next reporting period.
- d. Funds expended against effort during the reporting period with cumulative costs to date.

2. Final Report — The contractor shall submit a final report which documents and summarizes the results of the entire contract work, including recommendations and conclusions based on the experience and results obtained. The final report shall include tables, graphs, diagrams, curves, sketches, photographs, and drawings in sufficient detail to comprehensively explain the results achieved under the contract.

## SCOPE OF WORK FOR CONTRACT NAS8-31143 MODIFICATION

### BACKGROUND

Future work will concentrate on transferring the use of Landsat data to Tennessee State and Federal agencies through the application of investigations of several wetland characteristics and sensor-related properties found in the initial research and those that warrant further study. Further investigations are necessary to completely assess the ability of Landsat as a geographic tool for monitoring changes in the wetlands of western Tennessee.

### STATEMENT OF WORK

Through the interpretation and analysis of Landsat imagery, low and medium altitude color infrared (CIR) photography, and ground truth data, the following objectives are to be accomplished:

1. Establish liaison with TSPO, and through them, other state and Federal agencies, for the purpose of determination of state data requirements and to demonstrate the utility of remotely-sensed data to their needs. Prepare information transfer materials for meetings with these agencies and for a user workshop near the end of the contract period.
2. Perform more in-depth and rigorous accuracy testing of Landsat as a multiscale, multispectral, seasonal geographic tool for delimiting, monitoring, and mapping wetlands in western Tennessee. This procedure will test the accuracy of Landsat versus other forms and scales of imagery and ground truthing using information from mechanical tests of the imagery (i.e., incorporate data collected from the VP-8 image analyzer, the microdensitometer, and I<sup>2</sup>S color additive viewer).
3. Study the flooding problem in the western Tennessee wetlands. Using a multispectral, multiscale approach, areas of flooding and source areas contributing to the flooding problem, increased water turbidity, and other flood-causing phenomena will be mapped and investigated. The paramount responsibility of this objective is to analyze the ability of Landsat data and CIR photography as tools for identifying areas which exhibit flood problems in the western Tennessee wetlands area. An attempt will be made to emphasize satellite data and to deemphasize the requirements for aircraft data.

## SCOPE OF WORK FOR CONTRACT NAS8-31767

University of Missouri

### BACKGROUND

On January 5, 1976, the University of Missouri began Contract NAS8-31767 with NASA to conduct research on the application of satellite data to problems of resource use in the State of Missouri. To date, this research has been highly successful, and reports of results are appearing in preliminary published form. The laboratory at the Rolla campus has acquired some needed equipment.

It is now evident that this contract is productive and that technology transfer to the state is taking place. This success leads to the desire to extend the research into additional problems of resource utilization and to have more reports, workshops, and conferences to reach more state personnel. For this reason, additional work is outlined as follows.

### WORK STATEMENT

The basic objectives of the contract remain unchanged. However, the following additional research is desired:

1. Liaison with Minerals Industry — Working with the State Land Reclamation Commission and the Missouri Mining Council, a general conference on applications of remote sensing technology for the minerals industry will be planned and held. The contractor will determine conference content and will prepare any needed displays, reports, and/or hand-out literature.

2. Agriculture Workshop — The contractor will plan and implement at least one workshop presentation on mission planning and remote sensing applications for agricultural purposes. This may include liaison with the Missouri Department of Conservation in the study of timber conversion and habitat studies.

3. Hydrology and Pollution — Based on prior research in remote sensing applications to hydrology by NASA-Goddard Space Flight Center, NASA-MSFC, and their contractors (especially the reports of Ecosystems International, Inc.), the contractor will conduct additional research to relate it to Missouri's particular problems. This may include planning involving nonpoint-source pollution.



4. Remote Sensor Data Index — The contractor will update the Missouri Remote Sensor Data Index.

5. General Conference — The contractor will schedule and conduct a Second Annual General Conference on Remote Sensing for state-wide participation.

6. Diazo Techniques in Analysis — The contractor will prepare and publish, as a NASA CR report, a short simple manual on the use of diazo techniques in analysis of Landsat imagery.

7. Remote Sensing Analysis Manual — The contractor will prepare and publish, as a NASA CR report, a manual explaining simple and inexpensive ways to analyze and utilize remotely-sensed data.

8. Computer Analysis — Making maximum utilization of equipment already on-hand or obtainable from non-NASA sources, the contractor will procure inexpensive components which lead to a computer interactive analysis system for Landsat and other data. This will require liaison with researchers in other states, such as Georgia, Mississippi, and California. Up to \$ 4,000 of contract funds may be spent on equipment for this purpose without further approval of NASA, and up to \$ 1,000 may be spent on travel.

#### REPORTS REQUIREMENTS

The reports requirements for this extension will be the same as for the basic contract. The Final Report will now become due January 5, 1978. In place of the Final Report called for in the original contract, an Annual Report with format similar to the Final Report will be due January 5, 1977. The new Scope of Work calls for two manuals, which are to be in addition to the other reports. These will be assigned CR numbers by NASA and will be entered into the National Technical Information System (NTIS) by MSFC.

## SCOPE OF WORK FOR CONTRACT NAS8-30654

### Auburn University

#### BACKGROUND

The 1972 Engineering Systems Design of the NASA/ ASEE Summer Faculty Fellowship Program studied the requirements for an Earth Resources Information Retrieval System. Among their recommendations (published in NASA CR-61392) was the concept of a demonstration of a pilot system in cooperation with a state governmental office.

The primary elements of the system would include: (1) Earth resources information, primarily derived from satellite data, (2) an automated storage system (computer), and (3) one or more remote terminals capable of interaction with the computer.

For demonstration purposes, the initial information would be land-use in Alabama, as derived by the University of Alabama under Contract NAS5-21876. The Alabama Development Office (Office of the Governor), State Office Building, Montgomery, Alabama would be the state agency representing the "user."

#### WORK STATEMENT

The objective of the contract will be to develop and demonstrate a prototype Earth Resources Information Management System for the State of Alabama. Specific requirements are:

1. Computer Storage — The computer facility, including memory storage, will be provided (GFE) by MSFC, Computation Laboratory. This facility will remain physically at MSFC, but access via telephone will be provided. Responsibility for programming in Fortran IV language rests with the contractor, Auburn University.<sup>6</sup>

2. Remote Terminal — One remote terminal capable of interactive interface with the MSFC computer will be furnished to GFE by MSFC. This portable item will be located at Auburn, Montgomery, and other sites as required for the demonstration.

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6. Later modifications of this contract deleted the government's furnishing of computer facilities.

3. Initial Information Input — The contractor will be responsible for input of Earth resource information into the system. Initial input will be of land-use information for the State of Alabama, as derived by the University of Alabama. The initial information will be coded into cells of 1 km<sup>2</sup> each and will conform to the Universal Transverse Mercator (UTM) grid system for Zone 16.

4. Further Information Input — The contractor will be responsible for input of Earth resource information beyond the initial land-use input. This may include, but not be limited to: topology, slope, soil association, geology, land ownership, land value, population (census), and nearness to transportation and utilities. Update and extension to greater detail of land-use information will also be planned. The initial UTM system may be extended to smaller cells in urban areas. The contractor will be responsible for encoding of this information, but MSFC will furnish up to 100 translucent graph sheets for conversion of maps to the UTM grid at various scales.

5. Initial Test Site — The initial area for emphasis will consist of the Alabama counties of Baldwin, Escambia, and Mobile.

6. State Office Liaison — The contractor will be responsible for obtaining "user" requirement specifications from the Alabama Development Office (ADO) and for demonstrating the utility of the Earth Resources Information Management System to ADO and other state offices.

7. Applications Systems Verification Tests — This research and development contract will be operated as a verification test of the utility and cost-effectiveness of the demonstration in comparison with alternate methods of information retrieval. This type of test is known as an Applications Systems Verification Test (ASVT). The contractor will be responsible for reports (see Reports Requirements) which provide inputs to the ASVT formal report written by MSFC. These inputs include: (a) information on technical attempts to implement the Work Statement, including performance results; (b) information on major participating organizations, their roles and responsibilities; (c) schedules of subtasks and decision points which have specific measurable completion points; and (d) schedules of projected funding and manpower requirements by fiscal year and project phase keyed to decision points (including activity projected beyond the period of this contract).

## REPORTS REQUIREMENT

Monthly letter reports, a semi-annual report, and a final report (two parts) are required.

**SCOPE OF WORK FOR CONTRACT NAS8-30654  
MODIFICATION**

**WORK STATEMENT**

The contractor will acquire computer time, an acoustic coupler, and terminal to provide a batch interactive mode of operation for ARIS between the processing facility at Auburn University and the user facility in Montgomery, Alabama, at the Alabama Development Office. He will also develop and checkout the batch interactive mode.

## SCOPE OF WORK FOR CONTRACT NAS8-30654 MODIFICATION

### BACKGROUND

The existing contract has been on-going since April 23, 1974 and is producing satisfactory results.

### WORK STATEMENT

The objective of this extension to the contract will be to complete development of the Alabama Resources Information System (ARIS), to demonstrate it using actual resource information, and to make the final arrangements for complete transfer of the system, including all documentation.

1. The contractor will work with the Alabama Development Office and other state offices with the goal of identification of a state-owned or leased and operated computer system which could be used for operational implementation of ARIS after this contract and NASA's direct support has terminated. The milestone for accomplishment of the transfer to state operation will be July 31, 1976.

2. The contractor will be responsible for obtaining actual resource information on the Initial Test Site (as defined in Item 5 of the original Work Statement) and encoding it into the ARIS memory.

3. The contractor will assign highest priority to the transfer of ARIS from NASA support to State of Alabama support by the milestone date of July 31, 1976. Full documentation, with the exception of proprietary information, will be furnished in two copies: a reproducible set to MSFC and a set to the Alabama Development Office.

4. Utilization of the Auburn computers for ARIS demonstrations is authorized, and up to \$2,000 may be used to pay computer expenses without further approval.

5. The extension will be through August 31, 1976. This means that the Final Report will be due in draft form to the Contracting Officer by July 12, 1976. The provisions of the original Scope of Work (Requirements section) remain in effect. An Annual Report should now replace the 12th monthly report and will have a content similar to the previously specified semi-annual report. A semi-annual report should replace the 18th monthly report.

## SCOPE OF WORK FOR CONTRACT NAS8-31766

### Missouri Department of Natural Resources

#### BACKGROUND

On January 10, 1975, NASA Administrator James C. Fletcher wrote to Missouri Governor Christopher S. Bond. His letter suggested that satellite remote sensing might have benefit to Missouri, and he invited NASA-Missouri communications. Governor Bond replied on February 25, 1975. He focused on a newly-created Department of Natural Resources and stated that he had appointed Mr. James L. Wilson, Director, to make further contact. Mr. Wilson wrote to Dr. Fletcher on February 21, 1975 and focused upon the Division of Research and Technical Information and upon an Interdepartmental Council for Natural Resources Information. He also mentioned the role of the University of Missouri. On March 7, 1975, Ted Paludan, MSFC, and Jim Richards, Office of User Affairs, NASA Headquarters, visited the University of Missouri and the Missouri Department of Natural Resources. At those meetings, some preliminary suggestions were developed on joint NASA-State of Missouri-University of Missouri activities. Letters and telephone conversations have led to the contracted research outlined in the Work Statement.

#### WORK STATEMENT

The objective of the contract will be to conduct research in the applications of satellite data and to assist in initiating development of systems for these applications by the State of Missouri. This will be accomplished through identification of needs of the Missouri Interdepartmental Council for Natural Resources Information, by research, and by coordination with research at the University of Missouri. The research and development will include the following elements:

1. State Depository of Remotely-Sensed Data — In recognition of the need for efficient retrieval of data in research and applications of the data to state requirements, it is essential that the present file be upgraded. This will include acquisition of additional data and storage files, updating information, revision of the storage system, and establishment of a retrieval system.

2. Missouri Environmental or Earth Resources Information System — The Missouri State Natural Resources Information Council is charged with the responsibility of developing recommendations for a Natural Resources Data System that can meet the needs for pertinent state data base management and

provide optimum interactive compatibility with Federal and regional data systems. The Council's role is principally a coordinative one, and initial phases of the necessary research are underway. An inventory of data needs/ sources has been made available through cooperation with Washington University in one phase of their EODMS contract No. NAS5-20680. Other initial steps to be accomplished under this contract will include an inventory and analysis of information retrieval work in other states and an investigation of geographical coding systems in close coordination with University of Missouri researchers who are investigating elements of this same major problem. In cooperation with the University of Missouri, plans for an experimental demonstration utilizing information developed through proposed work at the University will be developed as a means of illustrating the application of the work to state activities. This task will be performed under the aegis of the Council. The demonstration will utilize a specific site to be selected jointly with the University which will be used as the example. Plans will be prepared for potential further elaboration of demonstration activity in the future to include ultimate use of an interactive terminal facility coupled remotely to the University of Missouri's computer system. The initial plan will represent a first step leading to a system design phase which will incorporate future trade-offs between expected satellite data and aircraft data, and possible use of Landsat or GOES Data Collection Platforms.



## SCOPE OF WORK FOR CONTRACT NAS8-31766 MODIFICATION

### BACKGROUND

The "background" content of the original contract outlined the correspondence in January and February 1975 between Governor Bond and NASA Administrator Fletcher, which led to the contract. The primary focus was upon the Missouri Interdepartmental Council for Natural Resources Information, for whom the Missouri Department of Natural Resources and the University of Missouri were designated as contracting agents.

Early in 1976, some of the objectives of the Council were redefined and reoriented. A new principal investigator, Mr. Robert E. Myers, was designated for the NASA contract. Progress was reported in written and verbal form, and has been satisfactory. Three subcommittees have been established by the Council to advise on the next steps to be taken.

### WORK STATEMENT

The original work statement called for two tasks, both of which will be completed by January 15, 1976. It is now logical to take those results and emphasize their use by the multiple state agencies. For that purpose, the following additional tasks are recommended:

1. Inventory of Data Sources and Data Needs — In order for state personnel to be encouraged to utilize NASA and other advanced data, they must be shown what is available. Due to the magnitude and diversity of such data, use of a computer will be essential. The contractor will accomplish this with the aid of the University of Missouri and with the advice of NASA and other NASA contractors.
2. Remote Sensing Summary Record — Again for the purpose of making data availability visible to state personnel, the contractor will develop a system similar to that of the National Cartographic Information Center so that satellite and aircraft data of the state can be cataloged and computer retrieved.
3. Liaison with Other Workers — The immediate partners in this research will be NASA, the University of Missouri (Contract NAS8-31767) and Washington University, St. Louis (Contract NAS5-20680 and its possible

follow-on). However, it is also important that systems under study by other states be considered to avoid unnecessary duplication. For that purpose, liaison by correspondence, telephone, and by actual visits is encouraged. Attention is specifically directed to projects at the Jet Propulsion Laboratory, the Earth Resources Laboratory, and the states of Mississippi, Georgia, and Alabama.

## SCOPE OF WORK FOR CONTRACT NAS8-32354

Washington University, St. Louis

### BACKGROUND

A primary Office of Applications objective is establishment of a land-use and environmental assessment capability. The Data Management Program and User Affairs Applications Transfer Program directly support that objective. MSFC is conducting a series of trade studies supporting analysis of the Office of Applications' plans to meet the objective. Key areas of trades are data quality versus system costs, classification of data distribution and dissemination systems to meet user needs, and other data base management (DBM) techniques.

Since June 1974, the Center for Development Technology at Washington University has been conducting a NASA research project in Earth Observation Data Management Systems (EODMS). EODMS results indicate that the data analysis trade studies would greatly benefit from further user inputs of real-world requirements, especially in land-use and environment assessment applications (i.e., Landsat follow-on etc.). Washington University has developed a set of baseline information requirements for remote sensing data in a five-state area (Missouri, Illinois, Iowa, Minnesota, and Wisconsin) and has established working relationships with user agencies in these states. The Washington University investigations also indicate the need for further research to modify or adapt existing data extraction and DBM systems for (1) information products and data base management to fill high priority needs in state agencies, and (2) a Landsat user's guide that will enable state and regional agencies to select data systems which best fit their needs and resource limitations.

The following contract requirements have been derived in part from (1) Data Program requirements, as previously described, (2) a Washington University summary of EODMS results, (3) a Washington University Proposal, State Agency Remote Sensing Data Management, dated August 13, 1976, and (4) a stated requirement by Office of Applications, User Affairs for a Landsat User's Guide.

### WORK STATEMENT

This contract effort is a research project to accomplish the following major tasks:

1. Develop a DBM system to translate the computer-compatible tape data into formats and information files of greater utility for at least one agency user, assure feasibility through basing the system design on techniques proven by current and past NASA ASVT's or demonstration projects, and fill some information needs identified by previous research as being of key importance to state agencies.

2. Produce a Landsat User's Guide which will provide a ready reference and detailed description of a hierarchy of available data products and systems for acquiring or producing those products with associated costs, applications range, technical requirements, and institutional constraints. This Landsat guide is not to be a duplicate of the revised ERTS User's Guide produced by General Electric; however, they should be complementary.

A. Task 1

1. Objectives. The specific objectives of the proposed research for this task are:

a. Identify in cooperation with the NASA COR's on this contract a few information products which have been proven feasible to produce in NASA ASVT's and demonstration projects and which fill a demonstrated high priority need in state agencies in the five-state region referenced in "Background" section.

b. Thoroughly inventory already-developed information systems which might be applicable to the project.

c. Design a DBM system for a state agency (1) to combine the information contained on one or more of these products approved by the COR with other information necessary to carry out key agency tasks, (2) to store, retrieve, and update this information; and (3) to produce it in forms useful to agency personnel.

d. Describe how the product production and DBM systems might be implemented within the political, financial and institutional constraints of typical state government as determined through previous research.

2. Scope. The contractor will emphasize information products derived from spacecraft-based remote sensing technology. The research will focus on systems which might be developed in the 1978-1985 timeframe to serve users

in a midwestern region, generally the same as the five-state region being investigated under the EODMS contract (Illinois, Iowa, Minnesota, Missouri, and Wisconsin), with potential application to meet user needs in any state. Using existing NASA or other available data base management systems (such as ARIS, Lumis, etc.), the contractor will adapt, modify, or construct a composite system design for a selected state agency based upon mutually agreed upon guidelines with that agency. It will determine in detail how the selected agency uses the information products, how it is combined with other information, employed to make decisions, and abstracted and distributed within and outside of the agency. The contractor will adapt the DBM system to enhance the selected agency's use of remote sensing data by making these operations more efficient and convenient.

The products to be analyzed will be taken from the list of EODMS priority products which have been determined to be both derivable from remote sensing and of proven utility to agencies in the five states primarily cited. Only products which have been proven technically feasible and have demonstrated user satisfaction in current and past NASA ASVT's or demonstrated projects will be analyzed. The product production system design will be based on the NASA demonstrated and proven techniques.

The major design problem will be the data base management (DBM) system. Current DBM systems, both NASA and others, will be investigated for potential application or for adaptation for use in this design, rather than the contractor attempting to design a completely new system. The contractor will consult with the COR's on the "proven techniques" and the DBM systems to be investigated. Technical and economic factors and institutional constraints will all be assessed and considered in the design of the DBM system. Among the specific systems to be investigated are ARIS, MERITS, MINIS, and systems in use at NSTL, ERL, and JPL.

3. Work Statement. The work statement for Task 1 includes the following:

a. The contractor will choose candidate information products for analysis by comparing EODMS priority products with those produced by NASA ASVT's and demonstration projects. The contractor will review NASA activities in ASVT's and demonstration projects (after consultation with the COR's) and find matches between those activities and the EODMS priority products list. Initially, the contractor will attempt to identify those information products which

are of proven utility to agencies in the five-state region and have been proven feasible to produce by NASA ASVT' s or demonstration projects.

b. The contractor will narrow the list of candidates to a few key information products which could serve high priority applications in agencies in the five states. The choice will be based on the contractor' s understanding of state agency priorities developed during the 2 years of EODMS research. The COR' s will approve the contractor' s final choices.

c. The contractor will recommend an agency for system implementation studies. He will select a state agency with a demonstrated interest in one or more of the key products selected in paragraph b. The agency must indicate desire and intent to implement the experimental system which evolves in this study. The agency selected will be approved by the COR' s.

d. The contractor will develop a detailed understanding of the agency' s information management practices. He will determine how the selected agency could use the information contained in the relevant key products; that is, how it could best be translated and combined with other information, abstracted and employed to make decisions, and distributed both within the hierarchy of, and outside, the agency.

e. The contractor will assess the institutional environment in which the systems must operate. He will investigate and analyze the budgetary, institutional, and political forces which limit the amount of agency resources devoted to gathering and using information. He will attempt to determine what new or additional resources, in both personnel and money, the agency has available to invest in a new information management technology. He will also assess the skills of personnel currently on the agency staff and equipment now used by the agency to see where these current resources can be applied.

f. The contractor will investigate and evaluate existing information extraction systems with respect to their capability to produce the key information products, including their costs on a long-term production basis. He will seek to find or adapt an extraction system to fit the selected agency constraints and serve the agency functions. He will also attempt to ensure that the system is compatible with or based on techniques that have been proven successful in NASA ASVT' s or demonstration projects. In his investigation the contractor will include systems recommended by the COR' s.

g. The contractor will design or adapt an agency DBM system. He will construct a system to serve the selected agency's information management needs within the constraints of available agency skills, equipment, and money. He will do trade studies on costs of NASA internal versus commercially available or modifiable systems. User information management practices will specify the data base structure as far as is technically feasible. In summary, this task entails adapting a data base design and planning the hardware, software, and procedures to support it. The goal throughout this effort will be to evolve a system which satisfies key information management needs while remaining usable, affordable, and maintainable.

h. The contractor will propose a management plan for implementing the system. The plan will list and schedule required investments in hardware and software and in training for operating and using personnel. It will also discuss ways for gathering user support within the agency and political support at the governor's level and in the state legislature, and will suggest possible sources for funding. The possibility of information dissemination by the public media will be studied, including possible periodic display of satellite-derived data in newspapers and on television aimed at the "grass roots" user (such as the individual landowner). The plan will be keyed to the needs of the manager who has responsibility for system development and implementation. It will be explained and detailed in a form that could be used, or adapted for use, by any state or state agency. The contractor should clearly understand that the objective of this task does not include developing a proposal for future implementation of the plan, but rather the achievement of an end product which could be implemented by a state agency with its own resources and personnel or with its own contractor. The contractor will assure that the agency partner in this plan development understands there will be no NASA resources available for plan implementation.

## B. Task 2

1. Objectives. Prior to considering the operational use of Landsat data, one of the most critical questions that an organization must answer relates to the necessary costs involved in utilizing these data. At the present time, this type of cost information is not effectively available to potential users. The objectives of this task effort is to produce a systematic and easily understood information source in the form of a Landsat data users' guidebook which will describe the various costs associated with the use of various types and forms of Landsat data, the range of application possibilities, and the technical and institutional considerations.

2. Scope. The activity will be directed toward a case study analysis of the existing technological base and capabilities to use Landsat data in three states. The three states will be selected jointly by the contractor and the COR's from the states studied in the EODMS project. The analysis will determine the varying user needs of each individual state and the information products necessary to satisfy these needs. This analysis will be based on the EODMS project results and will derive from the concurrent effort in Task 1. The information products will be analyzed in terms of the production methods and associated costs involved in the development of the representative products.

The cost information will be presented in a component or "building block" fashion to provide a user organization with a flexible guide for estimating the expenditures involved in meeting its specific needs. To ensure the necessary flexibility, a matrix of products and associated production methods versus the three representative states will be developed. This format should enable any state agency to use the matrix to select the products and desirable methodologies which will fulfill its needs and determine the aggregated cost of system development and operation.

3. Work Statement. Prior to initiating the contract work activities in Task 2, the contractor will make a detailed presentation on the project approach rationale, schedule, and specific end products that will result from the contract. The presentation will be made verbally and in written form, and will require approval of the NASA COR's to proceed. The work will consist of the following tasks.

a. Selection of Case Study States — The three states to be analyzed as case studies will be selected on the basis of diversity in a variety of criteria including their product requirements, present technological capability, and their degree of political/institutional latitude for potential adoption and use of Landsat products as a tool in meeting some of their environmental and natural resource management problems. The resulting case studies will be developed with adequate latitude so that any interested state can approximate, with reasonable accuracy, its particular case.

b. Identification of Representative Products — As a result of the analysis of the case study, states and their needs, as well as the EODMS priority needs list, the contractor, with approval of the COR's, will select several representative products (e.g., land-cover inventory or Landsat-based geographic information system) as a baseline for the performance of the cost



analyses. These products will be chosen on the basis of proven utility, extensive user need, varying complexity and production methods, and diversity in product requirements such as accuracy, timeliness, and the level of detail. The product characteristics will be defined in detail in this task to establish an effective foundation for the subsequent analysis.

c. Definition of Product Development and Scenarios — Several alternative scenarios will be defined describing the equipment, software, personnel, and procedures necessary to develop each of the selected products. For each of the elements comprising the scenario (e.g., equipment) different options will be presented, each reflecting a varying level of sophistication and resulting in differences in the specificity of the final product. The product development scenarios to be considered will include possible outside contracting to private industry or universities, as well as the states' in-house development. All tasks necessary for product development will be considered in the scenario, including data acquisition, preprocessing (including reformatting and rectification), field work, computer-implemented classification, and data presentation.

d. Determination of Costs Associated with Alternate Scenarios — Each of the alternate product development scenarios identified will be analyzed to determine the costs associated with its implementation. The cost analysis will address initial setup costs, including capital, labor, and operating costs. It will consider the costs of a user contracting the work to private industry, as well as developing an in-house system capability. It is important that the cost estimates be developed using information from organizations such as NASA Centers, selected private companies, and state agencies which are, or have been, operationally involved in the analysis of Landsat data. COR's will furnish guidance to assist the contractor in selecting companies and agencies to be used as source information.

e. Sensitivity Analysis of Costs — To provide some standard by which a user can measure how his specific requirements and resultant costs deviate from the cases studied, a sensitivity analysis will be performed on the costs associated with each scenario. The analysis will be directed toward determining the variations in costs resulting from product changes in information detail, scale, accuracy, timeliness, or product format. This sensitivity information will be included in easily understood form (scale, tables, matrix, etc.).

f. Development of User's Guide — The information developed in the preceding tasks will be formatted into a succinct and easily understood Landsat Applications Data and Information System Guidebook for Users. It is important that significant emphasis be placed on developing a presentation format which

will enable a user to readily derive cost estimates relevant and specific to his particular situation. The format, annotated outline, and contents of the user's guide will be reviewed and approved by the NASA COR's prior to the contractor proceeding. The user's guide should provide a flexibility to Landsat users similar to that which computer system guides provide for developers of computer systems. Essentially, it should enable him to piece together the system which will satisfy his needs and determine an estimate of the total costs expected. The guide will be reviewed in draft form by the COR's. The final format and distribution of the user's guide will be approved by the COR's prior to printing or publication.

### C. Contract Requirements Summary

In summary, in Task 1 the contractor will select a limited number of user information products based on satellite data which past NASA experience has "proven" can be delivered and can help solve user problems. They will match these products to selected high priority user needs as defined in the EODMS contract study. The contractor will identify a single state agency in one of the five states as working partner, define a system for using the identified data products to meet that agency's needs within its technical and institutional environment, and evolve a design for a data and information system that can provide the products, including extraction, processing, and DEM. Data base design effort will concentrate on an adaptation of existing NASA or other available "proven" DBM systems (or parts of systems), such as MERITS, MINIS, etc., and should not be a new DBM design effort. Finally, the contractor will produce a recommended plan by which the selected agency and others might implement the system within their own resources.

In Task 2, the contractor will produce a Landsat guidebook for users. The guidebook will include cost-benefits analyses of a hierarchy of user data products, from single-picture visual interpretation through advanced, completely automated sensor-to-user, multiple-use systems. This effort is also to take advantage of past NASA experience and the previous EODMS study results.

Research and work activities in Task 1 and Task 2 will be concurrent and coordinated so that overlapping or duplicative effort will be avoided and results can be mutually supportive. There will be two distinct, related but separate products of the two research tasks: (1) a design for and an implementation plan for a DBM system to meet a state agency's needs as described in Task 1, and (2) a Landsat Applications Data and Information System Guidebook for Users, as

described in Task 2. In addition, there will also be a final report produced by the contractor covering the research, results, and conclusions in both tasks as described in the "Reports Requirements" section.

#### D. Reports Requirements

The contractor shall submit Quarterly Progress Reports of all work accomplished during each quarter of contract performance. Reports shall be in narrative form and shall include:

1. A quantitative and qualitative description of overall progress.
2. An indication of any current problems which may impede performance, and proposed corrective action.
3. A discussion of the work to be performed during the next reporting period.
4. Expenditures to date and forecast of expenditures expected during the remainder of the contract period.

## SCOPE OF WORK FOR CONTRACT NAS8-30884

Georgia Southwestern College

### WORK STATEMENT

1. Provide instruction to Geological Applications Workshop participants between the time of the two scheduled workshops in contract NAS8-30884.
2. Hold additional sessions at participant's institution or agency so that direct instruction be given concerning the use of remote sensing techniques and data for a specific problem.
3. Acquaint the workshop participants with any proposed state system to disseminate satellite or other remote resources data.
4. Document different problems in the state where remote sensing, especially by satellites, has been used. Document the techniques (from visual interpretation to computer aided analysis) utilized on geological problems and assess the practical degree of success in those cases.
5. Report monthly by phone to the COR concerning contacts with user groups and state agencies.

## SCOPE OF WORK FOR GRANT NGR 01-001-023

Alabama A & M University

### BACKGROUND

The southeastern United States is an area richly endowed with natural resources. Because of its rich soils, abundant rainfall, and temperate climate, the South is one of the world's best wood-producing areas. The geologic and hydrologic potential of this region has become increasingly recognized in recent years. Alabama has great reserves of coal and other minerals which are quite accessible, and oil and gas fields have been located within the state.

In the southeast, as in most of this country, utilization pressures on our natural resources and indeed on the land surface itself will continue to grow more intense in the future. Better and efficient resource management and land-use planning is more critical than ever before.

Remote sensing has become an important tool in resource management and in land-use planning. Its value as a tool in locating, inventorying, monitoring, and mapping natural resources and land-use is being increasingly recognized. Many potential remote sensing uses in resource and land-use management await identification and development.

This proposed research will investigate and further develop and assess uses of remote sensing, emphasizing forestry, agriculture, geology, and land-use applications.

### WORK STATEMENT

1. To investigate, develop, and assess remote sensing uses of vegetation cover and landform as indicators of site and environmental conditions. Special emphasis will be placed on the use of high altitude and satellite imagery to classify land for natural resource and land-use planning and management.
2. To provide ground truth and technical support for NASA-MSFC personnel in work related to natural resource and land-use study and planning.

## SCOPE OF WORK FOR CONTRACT NAS8-31573

### Geological Survey of Alabama

#### WORK STATEMENT

The contractor is to start a punchcard file on coal data by coordinates in an eight quadrangle area. The data will be obtained at operations detected on remote sensing imagery, as well as company data from cores, states reports, and other geological sources.

Phase II of this work involves computer classification of four quadrangles (minimum) of strippable coal reserve. To utilize the digital topographic and Landsat tapes immediately and more effectively, a transition in the notation of data is required during the final months of the initial effort.

This is to add four new areas of old mines to this study of furnishing maps and thematic overlays and to utilize computer processing of Landsat and other data in the current and any new test sites. Results should be compared to conventional methods for an evaluation of error and costs.

## SCOPE OF WORK FOR CONTRACT NAS8-31006

University of Kentucky

### BACKGROUND

During late 1972 and until August 1973, the University of Kentucky performed research on several small watersheds in the state-owned Robinson Forest. This work involved both remote sensing (provided by MSFC) and in-situ sensing, and was performed under no-cost contract NAS8-39565.

Of particular concern recently has been the effect of coal strip mining on land and water quality.

The Cumberland Plateau Region of western Kentucky is a valuable watershed to central and eastern Kentucky as well as to adjoining states. The climax vegetation over most of this region is the mixed mesophytic forest which provides excellent protection to the easily erodable soils under the intense precipitation which is characteristic of the area. However, when the native vegetation is disturbed by man's actions or natural catastrophes, the soils erode rapidly and the clear mountain streams become heavily laden with silt and chemical pollutants. The area is isolated, of steep terrain, and thinly populated. Prominent land uses are hillside farming, forest harvesting, and surface mining. Although hillside farms and timber harvesting activities have decreased since the turn of the century, surface-mining activities have increased in the past 15 years, and thousands of acres of land are being denuded and exposed to accelerated erosion annually. Currently about 20,000 acres of land is being mined by this method in Kentucky each year. Since only about 10 percent of the total land suitable for surface mining for coal has been mined and an energy shortage is predicted for this country, this trend can be expected to increase for some time in the future. Despite efforts to reclaim this land, particularly through the enactment in Kentucky of the 1966 Surface Mining Law, results are discouraging. Sediment from the bare, steep outcrops continue to be deposited into the once clear streams of eastern Kentucky. In addition, it appears that timber harvesting activities will increase again in this area in the future, although not to the tempo of the early 1900's.

If the watersheds of this region are to be managed for quality water, then some method must be devised for identifying the nature and extent of various land uses, assessing their effect on water quality, and monitoring these activities on a

periodic basis. Remote sensing appears to offer some possibilities in providing effective survey monitoring techniques at a reasonable cost, but specific capabilities of different types of remote sensing must be worked out to solve the local problems. The capabilities and limitations of each sensor or technique must be demonstrated to interested agencies so that they can take advantage of these techniques in day to day problem solving.

Land-use planning at the state level is expected to be an area of emphasis in the near future. For the Commonwealth of Kentucky, the Department for Natural Resources and Environmental Protection will seek cost-effective means for land-use survey. Again, remote sensing may prove to be the answer.

## WORK STATEMENT

The objective of the contract will be to explore remote sensing techniques and determine their utility and cost-effectivity in determination of the effects of land-use practices on water quality in Kentucky. Specific requirements are:

1. Test Site Selection — The contractor will select one or more test sites for comparison of remote and in situ sensing of land-use and water quality. Since this selection may impact the collection of additional remotely-sensed data by NASA, the test sites must be approved by MSFC's Contracting Officer's Representative (COR) prior to procedure.

2. Ground Truth — Sample land-use and water quality information within the test sites will be collected by field survey by the contractor.

3. Remote Sensing — NASA-MSFC will provide, as Government Furnished Equipment (GFE), aircraft photographic records of the Robinson Forest in multispectral form. The contractor may request additional data which MSFC may obtain subject to availability of aircraft and supplies. The contractor will obtain satellite data for the test sites from the U.S. Department of the Interior, EROS Data Center, Sioux Falls, South Dakota, and may budget for its cost under this contract. Satellite data from the Earth Resources Technology Satellite (ERTS) and from the Skylab Earth Resources Experiment Package (EREP) should be obtained.

4. Vegetation Analysis — The contractor will analyze the remotely-sensed data at the several scales — multistage sampling — using ground truth for calibration and accuracy tests. This analysis will include the aircraft data,



and, where possible, the satellite data. The analysis will be directed toward recognition of two contrasting land-use practices: forested land under multiple-use forest management and surface-mined forested land reclaimed for subsequent agricultural use.

5. Effect on Water Quality — The contractor will devise a method for determination and display of the effect of land-use, as determined by vegetation analysis, on run-off water quality. This display may take the form of a mathematical model, equations, tables, maps, annotated photographs and/or other modes devised by the contractor. The choice of information display modes should consider the requirements of state and Federal environmental control agencies.

6. Color Additive Viewer — MSFC will lend GFE one color additive viewer for a period of 7 months: August 1, 1974 through February 28, 1975. MSFC will ship this item to the contractor, and the contractor will be responsible for its return to MSFC. This item will be similar to the International Imaging Systems Mini-Addcol Viewer previously lent to the University of Kentucky under contract NAS8-29565, value \$ 7,200; but the serial number will be determined later.

7. State Office Liaison — The contractor will establish and maintain liaison with the Commonwealth of Kentucky offices and departments which are concerned with strip-mine regulation, water quality, forestry, and land-use planning. These agencies will be appraised of the objectives of this research, and their advice and cooperation will be sought. If results warrant, the contractor may choose to submit an oral report of findings in the form of a seminar for state, Federal, and NASA officials.

8. Applications Systems Verification Tests — This research and development contract will be operated as a verification test of the utility and cost-effectiveness of the use of remotely-sensed data in comparison to conventional field surveys. This type of test is known as an Applications Systems Verification Test (ASVT). The contractor will be responsible for reports (see "Reports Requirements" section of this scope of work) which provide inputs to the ASVT formal report written by MSFC. These inputs include: (a) information on technical attempts to implement the Work Statement, including performance results; (b) information on major participating organizations, their roles and responsibilities; (c) schedules of subtasks and decision points which have specific measurable completion points; and (d) schedules of projected funding and

manpower requirements by fiscal year and project phase keyed to decision points (including activity projected beyond the period of this contract).

#### REPORTS REQUIREMENT

Monthly letter reports, a semi-annual report, and a final report are required.

## SCOPE OF WORK FOR CONTRACT NAS8-31006 MODIFICATION

### BACKGROUND

The research performed by the University of Kentucky on small watersheds under no-cost NAS8-29565 and on-going research under NAS8-31006 form the background for this work.

Some research activity would benefit from observation of more than one growing season. Examples include: (1) the effects of fertilization of natural timber stands, (2) effects of logging operations, and (3) seasonal temperature effects. The basic includes only one growing season (1975).

Since the ultimate concern of the Commonwealth of Kentucky in this activity will be minimization of adverse land-use effects, the evaluation of strip mining techniques and reclamation efforts would be valuable.

### WORK STATEMENT

The objective of the contract remains the same: to explore remote sensing techniques and determine their utility and cost-effectivity in determination of the effects of land-use practices on water quality in Kentucky. To accomplish this more comprehensively, the following specific requirements are added to those in the basic scope of work.

1. Fertilization Effects — Remotely-sensed and in situ data will be collected after fertilization of timber stands. The in situ data will consist of chemical analyses of water emanating from the affect watersheds. The remotely-sensed data will be used to access whether spectral signatures of vegetation are indicative of water quality. This should be multiseasonal.
2. Logging Effects — In a manner similar to Item 1, the effects of logging disturbances will be studied on one or more selected watersheds.
3. Mining Techniques Effects — In a manner similar to Item 1, the effects of different strip mining techniques and reclamation efforts will be studied.

4. Thermal Imagery — Subject to satisfactory performance and availability of equipment, MSFC will provide thermal imagery data of mutually-agreed test sites on a multiseasonal basis. The contractor will perform analysis of these data, will correlate them with ground truth data, and will define the observable effects of varied vegetative cover and water quality.

5. Commonwealth and Federal Agency Communications — The liaison activity (defined in the "State Office Liaison" section of the basic scope of work) will be expanded to aid the Commonwealth and NASA to define Commonwealth requirements as suggested in Administrator Fletcher's January 10, 1975 letter to Governor Carroll. This will amount to a "communications" activity, wherein the contractor will assist both parties in keeping an exchange of information flowing in both directions. The monthly letter reports should include a summary of this activity almost every month.

6. Liaison with ERDA — The contractor will establish liaison with the Energy Research & Development Agency (ERDA), specifically the Oak Ridge National Laboratory (ORNL), for the purpose of mutual exchange of data and information on the influence of coal strip mining on other uses of land and on water and other environmental qualities.

## SCOPE OF WORK FOR CONTRACT NAS8-31984

North Carolina State University at Raleigh

### BACKGROUND

As a result of the 1972 Announcement of Flight Opportunity for Skylab, North Carolina State University won selection as an investigator for the Earth Resources Experiment Package (EREP). Contract NAS9-13321 was granted by MSFC to North Carolina State on March 8, 1973. Dr. Charles W. Welby, Associate Professor of Geology, North Carolina State was principal investigator. A draft report of the findings of that research was submitted on September 25, 1975, and the final report in finished form is expected prior to contract (extended) expiration on January 15, 1976. The findings were extensive and significant, and were centered on applications of Skylab EREP data to North Carolina. This Skylab work establishes a baseline for investigation of applications of other satellite data to problems within the state.

### WORK STATEMENT

The primary objective of this research will be to utilize satellite data for solutions to selected problems of the State of North Carolina. Satellite data will be from Skylab and from Landsats 1 and 2. Aircraft data may be used in the multi-stage sampling mode and as ground truth, but emphasis should center on the Landsat data. The selected problems will be identified by the contractor, who will seek the advice of the State of North Carolina governmental agencies, such as the North Carolina Department of Natural and Economic Resources. The utility of satellite-derived information may be demonstrated to state agencies via informal working sessions, jointly-conducted workshops, special short courses, and reports — any or all of these as liaison with the state progresses.

Specific objectives include:

1. State Agency Liaison — The contractor will establish contact with appropriate state agencies in North Carolina, with the objective of having the agencies identify problems or activity which might be aided by applications of satellite remotely-sensed data. Emphasis should be on having the state personnel identify problems/activities, rather than have NASA or the contractor identify them. Agencies should be chosen who would be willing to cooperate in the research, and who would have the possibility for state-supported follow-on operations, if the research shows promise.

2. Selected Research Tasks — Based upon the problems/activities identified by the state, research tasks should be selected. For example, these might include follow-on research to the prior Skylab studies of trophic conditions of coastal lakes, survey of present land-use in critical areas, etc. Titles and brief outlines of selected research tasks must be approved by the NASA Contracting Officer's Representative (COR) or Alternate COR prior to proceeding with the research.

3. Research — Selected and approved research tasks will be performed by the contractor in a scientific manner.

4. Demonstrations and User Transfer Activity — The contractor will maintain liaison with the state agencies throughout the research phase, so that the findings will have maximum likelihood of being applicable to state problems. Results will be displayed to state personnel. The latter may include informal working sessions, workshops, special short courses, and short reports. If the latter are used (short reports), they may be extracts without cost information.

5. Data Sources — The contractor may use their own facilities for gathering of data, such as ground truth and aircraft sensing. Satellite data may be purchased with this contract's funds from the U.S. Department of the Interior.

## SCOPE OF WORK FOR CONTRACT NAS8-31850

Georgia Institute of Technology

### BACKGROUND

It has been shown by the Georgia Tech Engineering Experiment Station that imagery of selected peach orchards could be enhanced electronically to show varying degrees of health. Also, preliminary studies indicate that it may be possible to detect peach tree decline on the enhanced imagery before it is visible to observers on the ground.

### WORK STATEMENT

The objectives of this scope of work include the following:

1. Determination of the extent to which thermal and/or multispectral scanner data can be used to detect peach tree decline in its early stages.
2. An analysis of the best techniques for detecting and studying peach tree decline.
3. Determination of the best MSS band(s) to use in early detection of peach tree decline.
4. An evaluation of the potential application of the use of these data in future peach tree decline studies.

Data on magnetic tape and photographs will be analyzed to accomplish the previously given objectives. All available pattern recognition algorithms, including level slicing, clustering, and supervised classification will be attempted to determine the information available from the data. Each data processing technique will be employed with each data source (thermal, MSS). The results of these tests will be compared with available ground truth to determine the correctness of classification. A measure of the effectiveness of each classification technique/data source will be derived from the classification accuracy and the time/effort involved in producing the classification.

## DATA SOURCES

Data now available at MSFC will be made available (scanner tape and aerial photography). Additional MSS data and aerial photography of the selected test orchards will be obtained by MSFC and furnished to the contractor, subject to availability of aircraft. The contractor is authorized to purchase Landsat and other data from the Department of Interior, EROS Data Center, using contract funds.

## CONSULTANTS

The contractor is authorized to employ the services of consultants, up to one-half the total contract cost for technical advice.



## SCOPE OF WORK FOR CONTRACT NAS8-31850 MODIFICATION

### WORK STATEMENT

This is an extension to Contract NAS8-31850. All of the scope of work in the present contract will remain in effect. This extension is to add funds for processing multispectral data from the current growing season. The data will be lent to the contractor for the duration of the contract and will consist of magnetic tapes and aerial photographic film. The contractor is authorized to reformat magnetic tape as required to analyze the data.

A second objective of the contract extension is to present the results of the work in a report or "cookbook" which will permit the information to be readily transferred to users.

### GOVERNMENT FURNISHED MATERIAL

Magnetic tapes and aerial photo film.

### REPORTS REQUIREMENTS

No Change.

## SCOPE OF WORK FOR CONTRACT NAS8-30653

Georgia Institute of Technology

### BACKGROUND

This is an expansion of work performed under Contract NAS8-30653 and its previous expansion. The earlier phases established methods and software for Landsat data analysis and verified its utility to selected special problems for small test sites. This expansion would attempt to implement prior findings on a state-wide basis — leading to a totally state-supported operational system after the conclusion of this work. It would also provide a demonstration and liaison activity with other potential users. As with the last expansion, emphasis will be on applications of technology, not on development of new technology.

The objectives of this scope of work are:

1. Apply previously developed software for analysis of Landsat data on a Georgia state-owned computer system.
2. Implement an overlay computer structure so that ancillary data may be compared or contrasted with Landsat data.
3. While operating the above (primarily with Georgia agencies) provide demonstrations with other groups, such as the Southern Growth Policies Board.

Specific requirements include:

1. Software Selection — Data analysis software applied will be that previously developed by the contractor, NASA, or other NASA contractors. Preference will be given to software in the public domain. Contract funds may be expended for purchase of software and associated documentation.
2. Other Software — Software for geometric correction, coordinate transformation, and pixel registration will be obtained as in the previous paragraph.
3. Computer Selection — State-owned or leased computer systems at the Georgia Institute of Technology will be used for this research, and contract funds

may be used for computer time costs. At the conclusion of the research, recommendations should be made by the contractor for the optimum computer system for state operational use.

4. Ancillary Data Overlay — The system will be designed so that data and information from sources other than Landsat may be stored, retrieved, and compared with the basic Landsat land-use information. Implementation of this task will make maximum use of software and techniques already developed, such as that of the NASA Earth Resources Laboratory at Bay St. Louis, Mississippi, that for the Alabama Resources Information System at Auburn University, and that for the Tennessee State Planning Office at MSFC.

5. Geographic Location Coding — The contractor will establish a geographic location coding system for Georgia, based on liaison with state agencies, the Southern Growth Policies Board, and the Cartography Coordinator, EROS Program, U.S. Department of the Interior. If acceptable to state officials, preference should be given to a system compatible with those of other southeastern states — probably the Universal Transverse Mercator (UTM) grid.

6. Southern Growth Policies Board — The contractor will demonstrate the results of this research to appropriate elements of the Southern Growth Policies Board, Research Triangle Park, North Carolina. The objectives of this task will be to establish commonality in nomenclature, classification systems, and locational grids; and to explore the possibilities of a multistate resources information retrieval system based on Landsat data.

7. Data Purchase — The contractor is authorized to purchase Landsat data from the U.S. Department of the Interior, using contract funds.

8. Consultants — The contractor is authorized to employ the services of consultants, up to one-half the total contract cost, for technical advice and for the liaison tasks previously outlined.

9. Energy-Related Resources — The land-use information data base should permit and facilitate retrieval of locations of energy sources (such as mine, strip mines, oil and gas wells, and geothermal sources) and potential energy sources (such as under-utilized land that could be planted in energy-rich crops).

## REPORTING REQUIREMENTS

The reporting requirements are as follows:

1. Monthly Progress Reports — Narrative letter reports shall be submitted, with content as required in the contract for which this is an extension.
2. Final Report — The final report required by the parent contract will still be required, although it may now be called an annual report. A new final report will be required, with same content as previously specified.

## SCOPE OF WORK FOR CONTRACT NAS8-31553

### Marine Environmental Sciences Consortium

#### WORK STATEMENT

The contractor shall provide the necessary personnel to operate a Data Collection System as provided by MSFC. The system consists of two hydrolab sensor packages coupled to telemetry transmitters that send marine environment data to a ground station and recorders, and also to the Landsat satellite system. Additional equipment to gather weather data is also provided.

The contractor shall compile the data and publish it in a form suitable for the user community. Additionally, the contractor shall compile an operating history of the system that is sufficient to determine system weaknesses, cost of operation, and cost effectiveness of this type of system.

## SCOPE OF WORK FOR CONTRACT NAS8-30810

### Marine Environmental Sciences Consortium

#### BACKGROUND

One of the major tasks of the National Aeronautics and Space Administration is planning for future space exploration activities. Due to the increased national interest in the application of the NASA technology and capability in problems involving the environment, studies are required that will supply those data which will allow the planning for future space activities. The prime reason for this particular study is to obtain ground truth and in situ measurement of the major water resources of this region, and to determine the role that remote sensing might play in determining changes in this environment on the function of the major perturbing parameters.

It is also anticipated, with some reasonable expectation, that this initial effort can serve as a primary input to future efforts which will concern themselves with an integrated systems analysis to cover the complete hydrological cycle for the region, with a primary emphasis being the role that an integrated remote sensing program can support such an effort.

#### WORK STATEMENT

This statement of work covers a 6 month study to perform the initial program planning and primary user identification for the coastal zone of the southern Gulf states, with primary emphasis on the Alabama region, as are required to obtain essential background information that could be utilized in an overall systems analysis for water quality, water pollution, and pollution deterrents. Emphasis will be constantly maintained as to the ability of the NASA remote sensing data programs to be integrated into a user-partner type relationship for the transfer of the satellite and remote sensed imagery into a viable resource for state and Federal agency utility in planning for the optimum disposition of these valuable resources of water, water resources, wetlands, and the coastal/gulf area interfaces. Data will be obtained and presented such that a determination might be made as to the feasibility of obtaining certain major parameters of interest using available remote sensing capabilities and established research procedures.

The study discussed herein does not represent an approved program and will not necessarily lead to hardware projects.

## ASSUMPTIONS AND GUIDELINES

The following basic assumptions and guidelines shall be used in the performance of this study:

1. The Contracting Officer's Representative (COR) will concur in the selection of the experts in coastal and related fields, with the primary consideration that these specialists also have a firm realization of the user community needs and an awareness of the NASA related role in supporting these needs.

2. The COR will review and concur in the development of data sampling, timing and schedules, and any deviations in these schedules due to weather problems, personnel availability, or the availability of necessary supplies and equipment.

## EXPECTED RESULTS

This study will include, but will not necessarily be limited to, the performance of the following tasks, and with the understanding that these tasks might be modified in their emphasis as the work proceeds.

The four major tasks of this work are as follows:

1. Task (a) — Make a preliminary definition of a coastal zone research program which will utilize NASA remote-sensing capabilities. It is expected that this definition may in the future be expanded to include secondary regional influences (e.g., watershed changes, river resource influences, or the impacts of anticipated industrial expansions in the up-river regions).

2. Task (b) — Identify the data needs of users in Alabama and adjoining areas and develop a detailed plan as to how this data will be obtained and utilized.

3. Task (c) — Establish the organizational mechanisms within the Marine Environmental Sciences Consortium (MESC) for coordinating these research efforts for optimizing the utility of the NASA environmental applications interfaces.

4. Task (d) — Provide or obtain those portions of the preliminary ground truth data which are essential to support these initial goals.

These tasks will be completed within 6 months after initiation of the effort, with the remaining time to be spent in consolidating and compiling the results into a final report with recommendations for the systems analysis for the expanded region.

## PERFORMANCE REVIEWS

1. The contractor will visit MSFC, before beginning work, for an orientation briefing to mutually discuss details of the work to be accomplished and the contractor's method of approach.

2. At the completion of approximately one-half of the contract period, the contractor shall give a briefing (at a location to be determined) on the work completed and the work remaining, including the plan for completion. Special emphasis should be placed on the work to be accomplished during the final reporting period. The purpose of this presentation is to inform MSFC personnel of the work being done and to allow MSFC management to comment on and direct the approach being taken to assure that the desired results will be obtained.

3. The contractor shall make final review presentations at MSFC, and possibly at NASA Headquarters, at the completion of the study on dates agreed upon by MSFC and the contractor. These briefings will outline all work accomplished during the contract period, presenting the study results and conclusions as well as recommendations for further study.

## PROGRAM MANAGEMENT

1. The contractor shall assign a competent principal investigator and necessary staff to provide maximum continuity to the study effort.

2. NASA representatives will visit the contractor's facility periodically to evaluate technical progress. The COR may also call periodic meetings to resolve problems when required.

3. The contractor shall coordinate the exchange and integration of information with other government contractors performing related studies. This coordination and integration activity will be as specified by the COR and will include reports, presentations, conferences, and other special meetings.



4. The contractor shall obtain approval in writing from the COR prior to release of data, publication of articles, or release of any information resulting from this study.

5. All computer programs, or parts thereof, developed in connection with this study shall become the property of NASA and shall be prepared in accordance with written instructions from the COR.

#### REPORTS REQUIREMENTS

The contractor shall submit separate monthly progress reports.

## SCOPE OF WORK FOR CONTRACT NAS8-30380

Louisiana State University

### BACKGROUND

A study is underway to better understand the flows of mass and momentum within Mobile Bay by studying the results of a three-dimensional mathematical model which represents the bay and, when possible, comparing these results to measure data.

The flow within Mobile Bay varies significantly in all three spacial dimensions and with time. This flow is controlled by river flow into the bay's periphery, by tide activity in the adjacent Gulf, by winds and rains over the bay, and by the geometry of the bottom. The flowing fluid consists primarily of water, salt, and suspended sediments.

The objective of this research is restricted to the investigation of the effects caused by vertical variations of velocity, salinity, and sediment concentration. In the first phase of the study, a mathematical model was developed which describes the velocity and salinity fields. In the second phase of this study, (i.e., in the second year effort) the sediment conservation and deposition rates will be predicted by using the flow-field program from the first phase and doing the subsequent calculation to describe the sediment.

The status of the first effort is the development of tidal-bay model for Mobile Bay. The final report on this phase (which will be issued in January 1975) will include a description of this model, including listing of the appropriate program and comparison with physical model and field data.

### WORK STATEMENT

1. Run cases with the developed model to describe the range of tide river stage and wind conditions which are encountered in Mobile Bay.
2. Investigate flows of sediment and optimal deposition of spoilage within the bay.
3. Further investigate the influence of the turbulent model in the conservation laws.

The largest part of the effort in the second phase of study will be spent in accomplishing Item 1. The three-dimensional model takes a large amount of computer storage and is time consuming; therefore, the strategy of balancing improvements in computation efficiency against long run times will require much consideration.

#### JUSTIFICATION OF CONTRACT

The importance of Mobile Bay makes the understanding of the flow within it desirable. Flooding of the highways and businesses on the low lands of the bay's northern boundary due to high tides and winds is a frequent occurrence.

The bay contains a ship channel which is dredged and maintained by the Corps of Engineers. The saga of the bay filling this channel and man emptying the spoilage into surrounding waters is interesting in itself. Currently, a new ship channel at Theodore is being considered. Deposition sites for spoilage and the effects of spoilage islands on the flow patterns within the bay are of interest to the Corps of Engineers.

#### IMPACT OF DISAPPROVAL (COST, SCHEDULE, AND TECHNICAL PERFORMANCE)

All of the effort in developing a numerical model for Mobile Bay will be wasted if the computer program cannot be exercised sufficiently to evaluate the validity of the model. Applications of mathematical models are the only justification for having them. If the model's validity is not established, further studies would have to rely on the more expensive methods of field testing or using physical models. NASA does not research these other methods, but it has and does play a vital role in developing computational fluid mechanics. Application of this technology has not yet been made by the Corps of Engineers who have a primary interest in the results of this research.

## SCOPE OF WORK FOR CONTRACT NAS8-29100

University of Alabama

### WORK STATEMENT

The objectives of this project are the development and application of mathematical models for Mobile Bay capable of describing the hydrodynamic, salinity, and pollution loading behavior within the bay waters. Continuation of support for these goals is requested. Specific elements to be included in this project extension are:

1. The effect of river flow, wind, and tidal cycle on bay system behavior at abnormal conditions approaching storm surge status, on one extreme, and 10 year, 7 day low flows on the other.

2. The application and utilization of the 2 km bay models in the development of subsystem models for such areas as Theodore, Bon Secour Bay, Gulf-Bay exchange, etc., and for energy flow analyses of the bay ecosystem.

These efforts, coupled with on-going work related to pollution loading studies, should provide results that will interface with ground truth and remote sensing projects now in progress.

The status of the work scope outlined under Task I and Task II descriptions in the NASA Contract NAS8-29100 is given in Table 1.

TABLE 1. STATUS OF WORK ELEMENTS UNDER CONTRACT NUMBER NAS8-29100

Work Elements and Period	1974	1975
	Aug Sep Oct Nov Dec	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
<b>Task I</b> A. Review of Existing Mathematical Models for Estuarine Systems B. Development of a Hydrodynamic Model for Mobile Bay C. Acquisition of Data for Model Verification and Calibration (On-going Effort)	   XXXXXXXXXXXX	 (Completed 1/ 73)  (Completed 11/ 73) XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
<b>Task II</b> A. Development of a Material Transport Model for Conservative Species B. Verification and Calibration of the Hydrodynamic and Salinity Models (On-going Effort) C. Development of a Material Transport Model for Nonconservative Species 1. Water-borne Pollutant (Coliform) 2. BOD-DO D. Interactions of the Hydrodynamic and Material Transport Models (On-going Effort) E. Parameter Identification, Verification, and Calibration of the Nonconservative Material Transport Models (On-going Effort) F. Application of the Models to Specific Water Quality and/or Bay System Problems 1. River Discharge, Wind, Tidal Cycle Conditions (Normal) 2. Pollution Loading (Coliform) 3. River Discharge, Wind, Tidal Cycle Conditions (Abnormal) G. Development of Subsystem Modeling Routines 1. Mobile Bay Locations Requiring Small Grid Size Analysis 2. Energy Flow Analysis	 XXXXXXXXXXXX  XXXXXXX  XXXXXXXXXXXX  XXXXXXXXXXXX  XXXXXXXXXXXX  XXXXXXX  XXXXXXXXXXXX	 (Completed 11/ 73) XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX  (Completed 6/ 74) (Completed 10/ 74) XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX  XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX  (Completed 11/ 73) (Completed 10/ 74) XXXXXXXXXXXX  XXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

## SCOPE OF WORK FOR CONTRACT NAS8-29100 MODIFICATION

### WORK STATEMENT

The tasks to be accomplished for this extension of work and within allowable funding are the following:

1. An in-depth study of the interaction (coupling) of the energy and hydrodynamic models of Phase 1 with the material transport models providing an overall model of the entire bay.
2. A continuation of the application of the overall model to specific applications such as upsets caused by pollutant loading, or by natural disturbances such as storms or hurricanes, island configurations, channeling, cuts, etc.
3. The identification and examination of the parameters that are discernable using remote sensing techniques and which are pertinent to the accurate description of oxygen, water-born pollutants, and sediment concentrations within the system.

Items 1 and 2 are to be studied only to the additional extent that they serve as an adequate basis for Item 3, which should be the prime consideration for the effort in this extension of work.

These tasks cover the developmental phases of an overall plan to use the physical models for predicting the effect that upsets (such as pollution loading or natural phenomena) have on Mobile Bay. By combining these interactions, including experimental, mathematical and physical modeling aspects, an overall management plan to meet the industrial, recreational, and ecological needs can be initiated. The utility of remotely sensed data will be assessed as an operational technology for the continued surveillance of environmental problems.

## SCOPE OF WORK FOR CONTRACT NAS8-29100 MODIFICATION

### WORK STATEMENT

The contractor shall provide the necessary personnel to perform the following tasks:

1. Task I: Nonconservative Species Model Verification — Emphasis will be placed on the retrieval and collection of data suitable for the verification of all model equations developed under the contract for Mobile Bay. This applies particularly to the BOD-DO material transport models in which no useful, reliable historical data has been located. Coordination of effort with the Marine Environmental Sciences Consortium personnel to provide support in this area where it is compatible with their on-going bay studies will be pursued.
2. Task II: Extension of Model Constraints to Abnormal River Discharge, Wind, and Tidal Cycle Condition — Implement methods to investigate the effects on the physical behavior of the bay resulting from abnormal river flow, wind, and tidal conditions. Current and salinity distribution changes, abnormal tides, and pollution flushing characteristics under these extreme conditions would provide a baseline of data useful to agencies interested in water and energy resource developments along the coastline. Such information would also be useful to industries preparing design criteria for the construction of oil platforms, storage facilities, refineries, etc., related to nearshore and off-shore oil and gas exploration and deep water port operation. Commercial fishing industries and recreational developments could also benefit from the use of baseline data generated in this study.
3. Task III: Subsystem Modeling — Develop methods to focus on regions of the bay in which more detailed results than those currently obtainable with the 2 km model are required. Such problems as the pollution loading and distribution characteristics in the Bon Secour Bay area, Theodore Industrial Park area, and McDuffie Island complex require a grid size of perhaps a few hundred feet to develop solution strategies. Such systems can be developed with the aid of the 2 km models providing needed data at the water boundaries along these smaller systems. Development of this technology for Mobile Bay would also permit the assessment of local disturbances on the bay behavior too insignificant for proper analysis with the 2 km model. These could include, but are not limited to, channel configuration, waste loading characteristics, island or spoil bank configuration, etc.

Also, develop energy flow models for the bay ecosystem. These models would provide a better understanding of the biotic and abiotic interactions and hopefully set the stage for a coastal management policy based on factual data relating the industrial, commercial fishing, recreational, and municipal inputs into the ecosystem.

#### REPORTS REQUIREMENTS

Reports requirements are unchanged.



**SCOPE OF WORK FOR CONTRACT NAS8-29100  
MODIFICATION**

**WORK STATEMENT**

The contractor shall provide the necessary personnel and facilities to perform the following tasks:

1. Task I — Extend modeling capabilities to include sediment transport as related to turbidity in Mobile Bay.
2. Task II — Determine the effect of particle size and/or particle type on the model. This may require a population distribution study.
3. Task III — In conjunction with the Marine Environmental Sciences Consortium, formulate, document, and implement to data collection that provides the required inputs for verification/calibration of the math model for Mobile Bay.

## SCOPE OF WORK FOR CONTRACT NAS8-31979

University of Alabama

### WORK STATEMENT

The contractor shall conduct at least two workshops in cooperation with MSFC and other NASA contractors at the University of Alabama to instruct planning group technical staffs and others in the use of remote sensing data and techniques used by the University in their previous contractual efforts with MSFC.

The objective of the workshop sessions shall be to (1) promote the use of NASA remote sensing data to local and regional applications and to acquaint the attendees with simplified techniques with which to solve local problems and (2) to receive a feedback from the attendees after they have attempted to utilize remote sensing to determine whether new standards are required in NASA obtained remote sensing data before it becomes a practical tool for use by small planning groups.

## SCOPE OF WORK FOR CONTRACT NAS8-31785

### Mississippi State University

#### BACKGROUND

In 1973 MSFC initiated with Mississippi State University an Earth resources contract related to the Tennessee-Tombigbee Canal development project. The contracted effort was directed toward demonstrating practical applications of remote sensing to state and regional problems. The demonstration project participation by the five state Tennessee-Tombigbee Waterway Development Authority (TTWDA), the Corps of Engineers, and several state and regional agencies.

Also in 1973 Mississippi State University received a NASA University Affairs grant for a 3 year step-funded program devised to (1) demonstrate remote sensing applications in several discipline areas in cooperation with various state agencies and (2) develop at the University a regional center of expertise in remote sensing and other technology applications.

As part of the NASA User Affairs emphasis on continuation of this type user-applications activity, MSFC (in cooperation with Mississippi State University) proposed and had approved a modest SRT project.

This task proposal is based primarily on the MSFC prior involvement and cooperative applications research activity previously cited. One of the primary present concerns of Mississippi state and local agencies is the current Corps of Engineers 10 year project to develop a slack-water canal which will connect the Tennessee River and Mobile Bay/ Gulf of Mexico via the Tombigbee/ Alabama River Systems, thus providing a new major southeastern water route serving the eastern and midwest United States. The canal and the development activity obviously has a major economic and development impact on the state of Mississippi through which the major portion of the canal passes and in which most of the excavation/ construction activity will occur. The state and local governments, constrained to past and current practices and tools, are faced with almost insurmountable planning problems and decisions. They must have access to and use every possible modern technology development to support them. The prior Mississippi State University/ NASA research had demonstrated applicability of remote sensing in several discipline areas, particularly related

to the TTWDA. The state and local officials involved in the activity have expressed the need and interest in extending the applications through cooperative activity to the local agencies and departments. The regional element most directly impacted and concerned with the problem is the 17 county East Mississippi Council.

## WORK STATEMENT

1. Objectives — The primary objective of this task is to assist the East Mississippi Council and its constituency in meeting the current and future planning and development requirements and responsibilities in a more efficient and cost-effective way by:

a. Acquainting them with information extraction and interpretation techniques using remote sensing data and technology.

b. Demonstrating application of this information in various fields involving economic and development planning with specific concentration on the impact of the "Canal" project activity (i.e., canal excavations, dam construction, park and recreation siting, agriculture, and industrial activity). The contract tasks will include the following.

2. User Seminars — There will be two seminar workshops conducted over a period of 1 year, the first emphasizing objective (a) and the second emphasizing objective (b).

The workshops will be jointly planned by MSFC and Mississippi State University which, with aid of the University Affairs grant and other NASA contracts, has already established a degree of understanding and expertise in remote sensing techniques and applications and has become a recognized resource relied upon by the state government and by the TTWDA. Mississippi State University will organize and conduct the workshops.

MSFC will provide direction and advisory support and will furnish for each workshop a remote sensing discipline specialist together with limited equipment for demonstration purposes. The MSFC Earth Resources Office will also make itself available on call for follow-up telephone advice and discussion as needed by the users. Primary data to be used will be Landsat and EREP satellite data and NASA Aircraft Imagery. MSFC will provide the aircraft imagery, while the contractor will purchase the satellite imagery from the Department of the Interior using contract funds.

Major participants will include the Corps of Engineers, Tennessee-Tombigbee Authority, and other interested state and regional agencies.

The workshops will concentrate on the subject of land resource information. Land resource classification and interpretation techniques will be demonstrated. One or more test sites in the Tennessee Canal route in eastern Mississippi will be utilized as examples. Information of specific value to the Council constituency will be derived as a demonstration of the practical value of such applications and as an initial input to an information data base which the Council desires as a basis for a model long-range development plan for the region.

Although development or definition of an automated information storage, retrieval, and transfer system will not be possible within the timeframe and resources of this contract, the Mississippi users can be introduced to the technology and existing systems of this type and the use of remote sensing as a major input to these systems.

For this purpose, up to 20 percent of the contract funds may be reserved to be used to obtain services of and seminar participation by appropriate experienced users of such information systems in other states.

The second seminar and follow-on activity should result in an outline plan for an information system, as previously discussed, for the East Mississippi Council region.

## SCOPE OF WORK FOR CONTRACT NAS8-30539

Ecosystems International, Inc.

### BACKGROUND

One of the largest and most important tasks of NASA is planning for future space exploration activities. This includes an identification of useful applications of the potential offered by remote sensing instrumentation, and necessarily requires the investigators in this area of work to be aware of the problems and needs of a selected family of possible users of this information. It is expected that a major user for this type of information will be the Water Resources Manager, for whom this effort will provide the basis for a predictive capability for future hydrological events.

### WORK STATEMENT

This statement of work covers an 11 month study to develop water resources planning models, specifically developed upon the capabilities of remote sensing. This model will be designed for maximally satisfying requirements of (1) providing adequate accuracies when applied to ungauged watersheds and (2) measuring shifts in characteristics of water sheds undergoing rapid development, where long historical records have lost their utility.

To the maximum extent possible, the inputs to the effort will be surface observables, specifically those accessible from space imagery. Those parameters not directly accessible from space will be based upon those commonly available, such as county percolation tests, climatological records, and agricultural reports.

### ASSUMPTIONS AND GUIDELINES

The following basic assumptions shall be used in the performance of this investigation. For the purpose of determining the efficacy of the model, a set of watersheds will be used that are amenable to close observations by alternate methods (e.g., rain gauges, good historical records, or present watershed/reservoir management efforts).

A pursuit of the major influencing factors ("drivers") on watersheds of varying morphology will be made, and these parameters identified which constitute the major perturbations and critically influence the model.

Peak events will be surveyed to determine their applicability to developed model, as well as the models ability to handle these events.

## EXPECTED RESULTS

This study will include, but not necessarily be limited to, investigations and solution of the following problems: the development and complete documentation of a mathematical technique which will have as its prime characteristic the general description of those hydrological parameters which characterize a watershed, with emphasis on a hydrological planning model of direct utility to water resource managers.

This investigation has three objectives: (1) critical investigation of "driver" phenomena such as climatology of precipitation, infiltration, soil characteristics, overland flow, and evapotranspiration; (2) preliminary definition of generalized watershed planning models and their application to existing watersheds; and (3) preliminary sizing of the role of remote sensing in the construction of watershed planning models.

Realistic ranges of values of the parameters, including variations, will be factored into the analyses. The result of this effort will be the orderly isolation, definition, cataloging, and presentation of watershed regimes, of the range of parameters influencing each regime, and of the errors occurring due to neglecting specific parameters or combinations thereof.

## PERFORMANCE REVIEWS

1. Before beginning work, the contractor will visit MSFC, for an orientation briefing to discuss details of the work to be accomplished and the contractor's method of approach.

2. At the completion of approximately one-half of the contract period, the contractor shall give a briefing (at a location to be determined) on the work completed and the work remaining, including the plan for completion. Special emphasis should be placed on the work to be accomplished during the final reporting period. The purpose of this presentation is to inform MSFC personnel of the work being done and to allow MSFC management to comment on and direct the approach being taken to assure that the desired results will be obtained.

3. The contractor shall make final review presentations at MSFC, and possibly at NASA Headquarters, at the completion of the study on dates agreed upon by MSFC and the contractor. These briefings will outline all work accomplished during the contract period, presenting the study results and conclusions.

#### PROGRAM MANAGEMENT

1. The contractor shall assign a competent principal investigator and necessary staff to provide maximum continuity to the study effort.

2. NASA representatives will visit the contractor's facility periodically to evaluate technical progress. The COR may also call periodic meetings to resolve problems when required.

3. The contractor shall coordinate the exchange and integration of information with other government contractors performing related studies. This coordination and integration activity will be as specified by the COR and will include reports, presentations, conferences, and other special meetings.

4. The contractor shall obtain approval in writing from the COR prior to release of data, publication of articles, or release of any information resulting from this study.

5. All computer programs, or parts thereof, developed in connection with this study shall become the property of NASA and shall be prepared in accordance with written instruction from the COR.



## SCOPE OF WORK FOR CONTRACT NAS8-30539 MODIFICATION

### BACKGROUND

Past performance on existing Contract NAS8-30539 has shown that:

1. The prediction of peak runoff, especially in ungaged watersheds, is of significant importance to users for the purpose of planning, sizing, and designing waterworks.
2. To predict peak events with adequate accuracy, conventional models must be augmented by reflecting a deeper understanding of the phenomena involved.
3. The depth of these formulations need not be carried to the ultimate, but must be sufficient to the end sought (i. e., to the accuracy desired).
4. Of the many phenomena and relationships underlying the behavior of hydrologic quantities, only a few are dominant for planning models; others can be neglected, or, in the extreme, factored in as constant corrections.
5. The crucial phenomena regulating peak events are, to a significant extent, surface-dependent and thus highly amenable to remote sensing.
6. For the cases where subsurface phenomena play a significant role, peak events can still be predicted through a combination of remotely sensed observables and available subsurface parameters.
7. Among the subsurface parameters, soil humidity plays an important and quantifiable role.

### WORK STATEMENT

The contractor shall provide the necessary personnel and facilities to qualify the previously mentioned results and test them against a number of case records sufficiently large enough to demonstrate a high degree of reliability. This would allow prospective users of the results to acquire the necessary degree of confidence. Specifically the contractor shall perform the following tasks:

1. Task 1 — Quantify the relationships between the major influencing factors ("drivers") for a sufficiently large set of test watersheds.

2. Task 2 — Integrate all the mathematical formulations developed thus far into a general planning model, sufficiently complete so as to describe the relationships between "drivers" with adequate accuracy, yet sufficiently simple as to be usable by the majority of routine operational users.

3. Task 3 — Test of the complete planning model against the actual occurred events (rain rates, durations) and physical parameters (slopes, surface cover, infiltration, soil capacity, and so forth) of a sufficiently large set of test watersheds. By sufficiently large is meant a number adequate to yield statistical confidence. This number is estimated to be between at least 10 and not in excess of 50 samples.

4. Task 4 — Quantify the sensitivity of the "drivers" versus results. By this is meant the determination for a given specified precision of the prediction of the planning model's output, the determination of how accurately must each "driver" quantity be measured, and, further, what errors are committed by neglecting those phenomena which are not "drivers" (for example, evapotranspiration, interception, etc.).

5. Task 5 — Perform a preliminary analysis of the capability of remotely sensed imagery to identify and measure observables related to the "drivers," and supply preliminary numerical results of this analysis.

## SCOPE OF WORK FOR CONTRACT NAS8-30539 MODIFICATION

### WORK STATEMENT

The contractor shall provide the necessary personnel and facilities to complete the mathematical model, fully prove the application of Landsat imagery, and demonstrate them to the selected users. Specifically the contractor shall perform the following tasks:

1. Task 1 — Complete the mathematical model by carrying its development to a satisfactory level of performance. This task shall be completed within 6 months from beginning of the work.
2. Task 2 — Apply the experimental techniques developed under previous phases of this work to derive physical model parameters from Landsat imagery for a set of approximately 5 to 12 experimental watersheds; test the performance of the model against the historical records.
3. Task 3 — Document the experimental procedures for extracting information from the Landsat imagery and applying it to the model.
4. Task 4 — Select users and demonstrate the model and the corresponding use of Landsat imagery to these selected users, exploring with them the active transfer of remote sensing technology to their application. If applicable, assess and document the nature and magnitude of potential impediments to this technological transfer.

### REPORTS REQUIREMENTS

No Change.

## SCOPE OF WORK FOR CONTRACT NAS8-32218

### University of Mississippi

#### OBJECTIVES

The objectives of this short-term planning project are listed as follows:

1. To determine the need within the area to be served for
  - a. Planning and utilization symposia.
  - b. Photogrammetry short-courses.
  - c. Workshops to demonstrate uses of remote sensing.
2. To develop materials for one pilot-project workshop in the uses of remote imagery.
3. To conduct one workshop on a pilot-project basis.
4. To begin the collection and cataloging of remote imagery needed to support the short-courses and workshops which our surveys identify as needed.
5. To continue to develop the capability of the several University faculty to be involved in this project in the techniques of photo and radar image analysis and interpretation.
6. To identify those items of analytical instrumentation needed for teaching photo-interpretation and image analysis selected to meet the needs of identified users.
7. To identify those items of analytical equipment needed for new applications of technology to natural resource development and land-use planning.
8. To assess the need for and to establish a mailing list of potential users and trained planners to receive an information newsletter.

## WORK STATEMENT

The contractor will survey the potential users in the region to ascertain the most appropriate subject matter content for training symposia and workshops. This will be accomplished by visits to key population centers to discuss the program with city planners, small industrial users, and others likely to benefit from training in the techniques of remote imagery. Thus, the training programs will be keyed to the interests and expertise of the user community.

An ancillary purpose of the planned visits among potential users would be to assess the need for a users newsletter and the level of sophistication of the readership vis-a-vis knowledge of remote sensing technology.

Following the survey of user needs and level of expertise, materials would be gathered to present the first workshop for selected participants. The precise content of this workshop would be determined by the needs of the participants. It is expected that the presentations would be somewhat rudimentary in comparison to the workshop conducted at ERL because of the sophistication of their equipment in comparison to that available to the University. The workshop will be presented during the last month of this planning project.

Planning for and presenting the workshop will give the co-investigators an opportunity to assess what, if any, imagery and equipment will be needed to conduct future workshops, as well as to pursue some studies aimed at technology development.


## APPROVAL

### EARTH RESOURCES — REGIONAL TRANSFER ACTIVITY CONTRACTS REVIEW AND SUMMARY

By J. Bensko, Jr., J. L. Daniels, S. W. Downs, Jr.  
N. L. Jones, R. R. Morton, and C. T. Paludan

The information in this report has been reviewed for security classification. Review of any information concerning Department of Defense or Atomic Energy Commission programs has been made by the MSFC Security Classification Officer. This report, in its entirety, has been determined to be unclassified.

This document has also been reviewed and approved for technical accuracy.

  
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J. T. POWELL  
Director, Data Systems Laboratory